March/April, 1978
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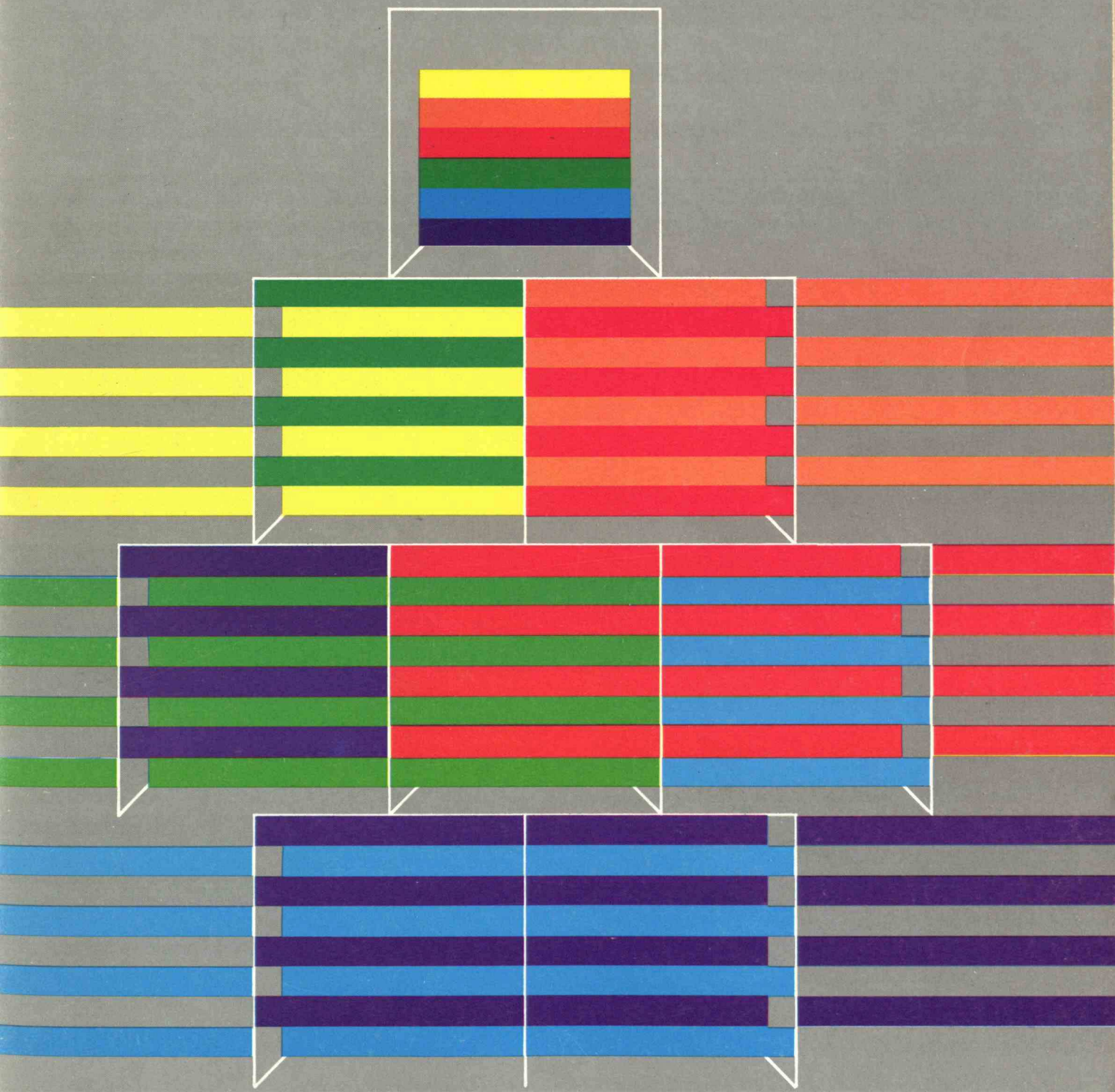
Organizing for Effective Innovation

The Auto Emissions Mess
An Exploration of the Comets
The Nuclear Waste Shell Game

Technology Review

Edited at the Massachusetts Institute of Technology



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EMPIRE
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THE SECOND
MRS TANQUERAY

"This is the set where they shot 'Hello, Dolly!' What you can't see is us pumping oil behind it."

"One of the strangest places I ever produced oil," says Gulf Production Superintendent Eddie Culbertson, "was right here in Los Angeles in the back lot of the 20th Century-Fox studio.

"We showed them how they could have their oil *and* their movies."

"They found a big oil field right under a permanent set being used for shooting the movie 'Hello, Dolly!' in 1969.

The indirect approach

"How do you get at the oil without disturbing the set, the streets, or the buildings? With a technique called directional drilling. The oil is under the city as far away as one mile from the surface location of the drill sites, which are hidden by the scenery.

"Directional drilling has other advantages. You can drill 20 or 30 wells from one drill site instead of filling the landscape with oil derricks. Or you can drill for some offshore oil without putting the drilling rig right in the water.

"Behind the scenery are 22 producing oil wells."

Keep America beautiful

"Sometimes it's a real challenge getting the oil without spoiling the landscape. Directional drilling is one way to do it. There are many more.

"Getting the oil out and preserving the environment is a challenge, but I'd say we were meeting it very well."

Gulf

Gulf people: meeting the challenge.

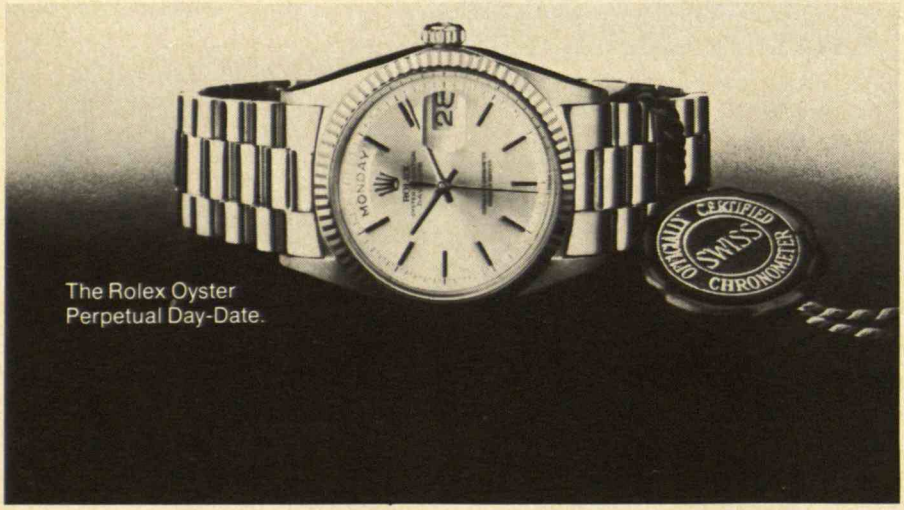
Main intersection at a Hollywood oil field.

Gulf Oil Corporation

Announcing The Winners of The Rolex Awards for Enterprise

In September 1976, to celebrate the 50th anniversary of the Rolex Oyster, we launched the Rolex Awards for Enterprise.

"To provide financial help for projects which seek to break new ground in their particular sphere and which capture the spirit of enterprise shown by Rolex, and Rolex owners, over the last 50 years."



The Rolex Oyster Perpetual Day-Date.

We offered a total of five awards of 50,000 Swiss francs each, together with a specially inscribed Rolex Chronometer.

The response from around the world was overwhelming and over 3,000 projects were finally considered.

The Winners

This spring, Dr. Billy Lee Lasley, Kenneth Lee Marten, and Francine Grace Penelope Patterson from the U.S.A., Luc Jean-François Debecker of Belgium, and Georges Marcel André Delamare of France were invited to Geneva, where they were each presented with a check for 50,000 Swiss francs, together with a specially inscribed gold Rolex Chronometer.

The Book

"The Rolex Awards for Enterprise," by Gregory B. Stone, will be published later in the year as a lasting tribute to the Rolex Spirit of Enterprise. The book will give a full account of the winning projects along with the details of hundreds of other entries. In the meantime, if you'd like more information on the winning entries, write to Enterprise, Rolex Watch U.S.A., Inc., Rolex Building, 665 Fifth Avenue, New York, New York 10022.

ROLEX

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Articles

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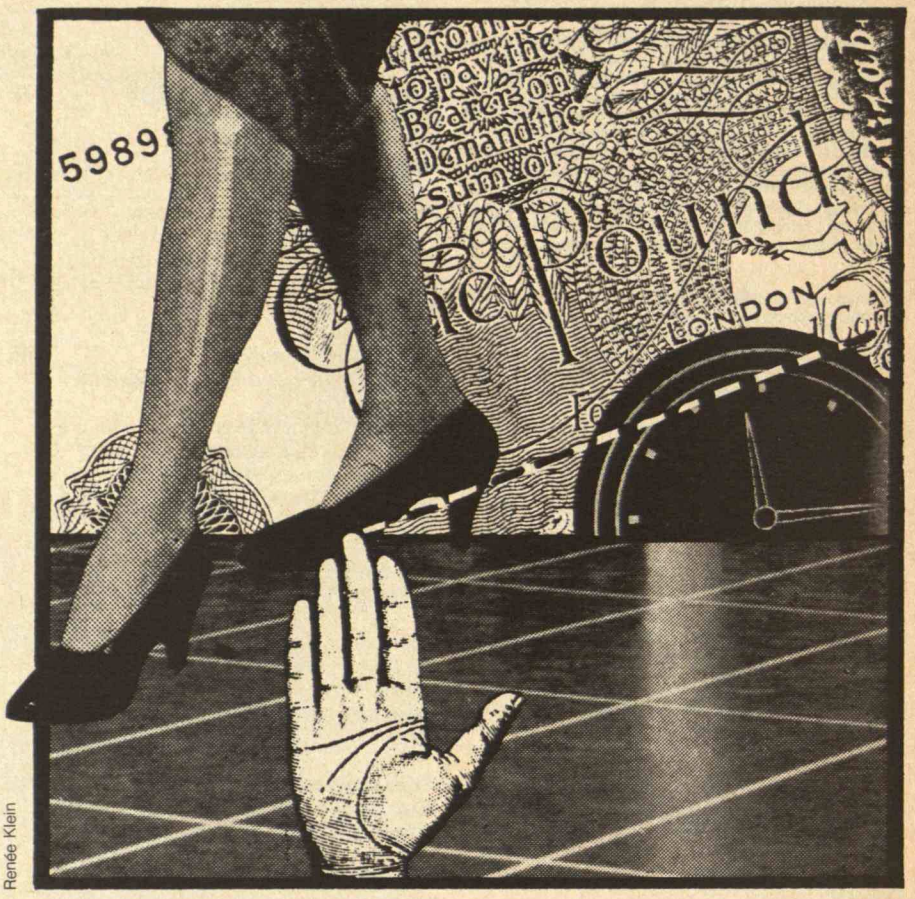
Measure for Measure

Kenneth E. Boulding is President-elect of the American Association for the Advancement of Science, Distinguished Professor of Economics at the University of Colorado at Boulder, and a director of the Institute of Behavioral Science. He writes regularly for the Review.



Renée Klein

Measurement is regarded as the key that distinguishes science from the empirical and instinctive wisdom of ordinary life. But with any scrutiny, we find measurement a highly arbitrary business, hardly scientific at all. Younger physicists are constantly changing their units, no doubt in order to mystify their elder colleagues. And in our own society the introduction of the metric system threatens to confuse us all.

Any measure is the ratio of a given quantity to some arbitrary quantity of a variable which is regarded as a unit, so that the number which represents the measure is equally arbitrary. Thus a person's height may be represented by 6 ft., 72 in., 2 yds., 1.83 m., 183 cm., or 1,830 mm. A person's height can be represented by any number at all depending on the unit we choose.

Duodecimal Days

How we express a number depends on our scale of notation. By convention we count in tens — presumably because we have ten fingers. Many early systems, however, were duodecimal rather than decimal, not because some ancient race had 12 fingers, but because counting in twelves is really more convenient than counting in tens. Twelve divides by two, three, and four; ten only by two and five. We see this, for instance, in the hour, which not even the French revolutionaries dared to touch and which survives as a lonely monument to duodecimalism. Nobody knows the origin of the hour, but it might have originated in the necessity for dividing the day — the natural unit of time on earth — into convenient parts. It would obviously be useful to talk about half a day and about a quarter of a day, but then for many purposes we divide the day into thirds: a third of a day for sleep, a third of a day for work, a third of a day for other things. It is not surprising that this schedule resulted in a total of 24 hours: 24 divides by two, three, four, six, eight and 12. A half-day is 12 hours, a third of a day is eight hours, a quarter of a day is six hours, and so on. One can imagine how magnificently inconvenient a day would have been, divided into ten equal periods (according to good decimal principle), no doubt called "dours." A quarter of a day would have been 2½ dours; a third of a day 3⅓ dours.

Another artifact of the duodecimal system is the 12-in. foot. And the old English currency combined decimal and duodecimal with 12 pence to the shilling, and 20 shillings to the pound. Even multiples of 7 sneaked in via the guinea, which was 21 shillings.

Most systems of measurement originated in human experience. The foot, of course, is a foot, though it might better be called a shoe. I have just performed an experiment and discovered — to my extreme gratification — that my shoe is exactly 12 in. long. The inch derives from the distance across the thumb, and I am glad to report that my own thumb (depending on how much one squishes it) is exactly an inch across at its widest. It is no doubt just a happy coincidence that 12 thumbs make a shoe. The hand, which I think is 4 in., is of course a marvelous way to measure horses. My own hand is only about 3¾ in., but then I never did like horses. I believe the yard was the distance from Henry VIII's nose to the end of his extended arm — a fine way to measure royal purple. I would gather a little more velvet in my arm's reach than Henry VIII; it extends about 36½ in.

I will not make a passionate defense of the rod, pole, or perch: all 5½ yards — about as long a rod, pole, or perch as one can carry conveniently. These units also had the advantage of being a quarter of a chain, which was about 22 yards — again, about as heavy a chain as one can carry. A furlong was 10 chains, a casual nod to decimalism and the standard length of the furrow in the medieval village.

I have an unreasonable and indefensible affection for the mile. Colorado cannot possibly embrace the metric system: how can Denver be the 1,609.34-m.-high city and how can our magic 52 14,000 ft.

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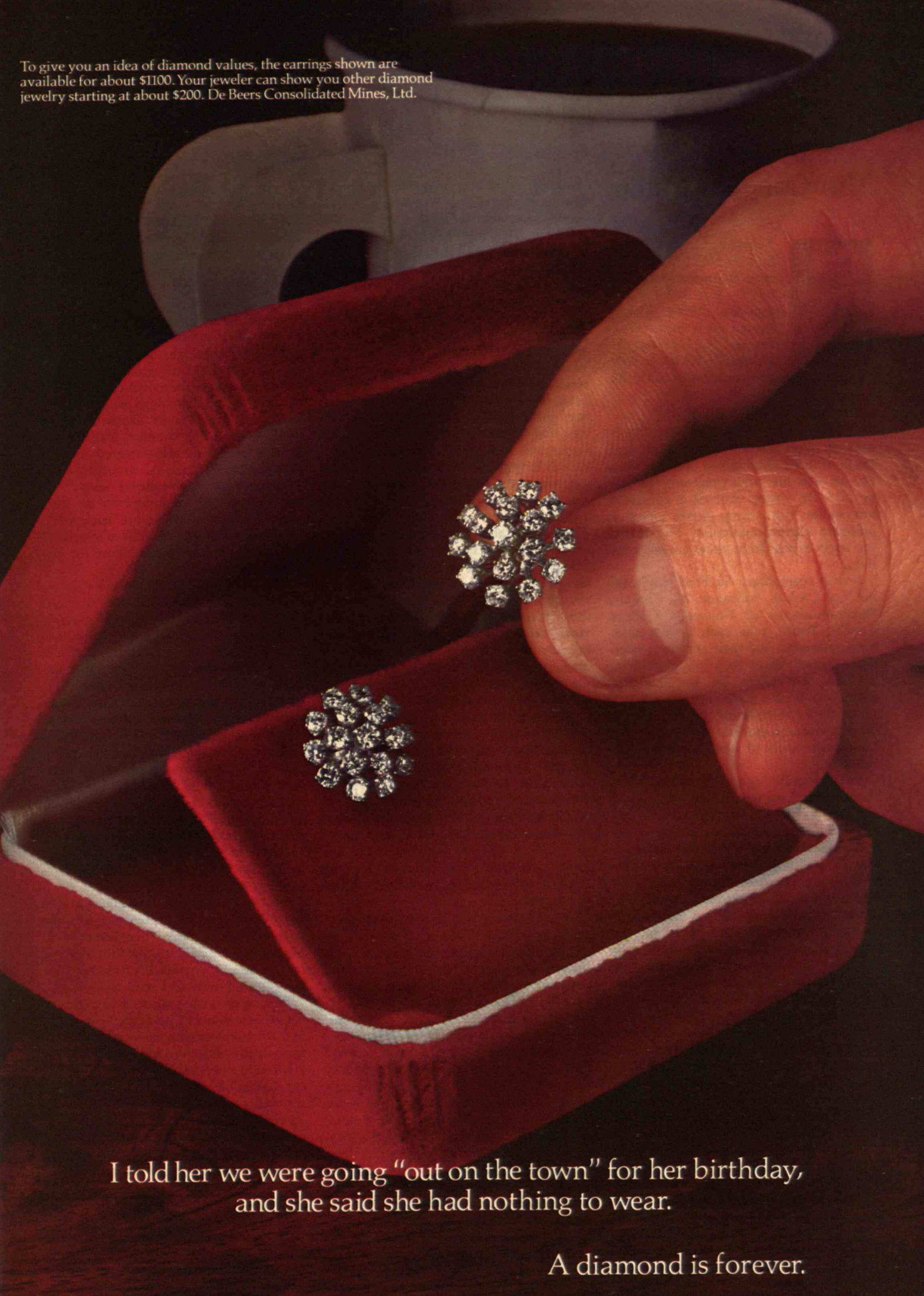

To give you an idea of diamond values, the earrings shown are available for about $1100. Your jeweler can show you other diamond jewelry starting at about $200. De Beers Consolidated Mines, Ltd.

I told her we were going "out on the town" for her birthday, and she said she had nothing to wear.

A diamond is forever.

The Cosmic Cradle

Robert C. Cowen, Science Editor of the Christian Science Monitor, *won the 1977 A.A.A.S.-Westinghouse Science Writing Award. He is former President of the National Association of Science Writers, and is a regular contributor to the* Review.

Earth in orbit sweeps up some 16,000 tons of interplanetary matter each year, much of it the remnants of decaying comets. Are new life forms present in this stellar gift? Do viruses evolved in comets or interstellar dust bring novel genes to influence earthly evolution? Did earth's life itself evolve from these cosmic seedlings?

British cosmologist Sir Fred Hoyle and his Sri Lankan colleague N. Chandra Wickramasinghe of University College, Cardiff, Wales, take such far-out questions seriously. And their answer is a tentative "yes." While their speculations so far have few takers, the fact that Drs. Hoyle and Wickramasinghe are willing to stake their professional reputations on these audacious theories shows how fast the young science of astrochemistry is developing.

Two decades ago, few astronomers thought anything worth calling chemistry occurred in space. The cold and near vacuum of the "void" and the stars' molecule-destroying ultraviolet radiation seemed too hostile an environment for chemicals to survive. But more recently, astrochemists have identified some four dozen molecular species. Some are as simple as water or carbon monoxide. Others are as complex as alcohol or as heavy as cyanotriacetylene (molecular weight 99). As B. Zuckerman of the University of Maryland has observed, astronomers have been forced to recognize that "operating in a completely non-terrestrial environment, interstellar chemistry produces both everyday molecules likely to be found around the house and exotic species never before observed on earth."

Indeed, astronomers have been forced to recognize astrochemicals as major cosmic entities, without which they would have been unable to understand fully our galaxy or its star systems. And perhaps they would have missed a key participant in the origin of organic life.

Thanks to the millimeter-wavelength radiation of carbon monoxide, a ubiquitous molecule, radio astronomers have recently been able to map molecular distribution. They find the chemicals concentrated in what they now call, with respectful capitalization, Giant Molecular Clouds. There are small molecular clouds, as well. Measuring 30 to 180 light years across and with 100,000 to 10 million solar masses, these great dust clouds command astronomers' respect. In them, various types of molecules are concentrated in densities as high as 700 to the cubic centimeter. That compares to about one atom per cubic centimeter for interstellar space in general. The clouds themselves seem to be concentrated in a ring 12,000 to 25,000 light years from the galactic center and in the center itself. No one knows how many clouds exist, but 1,000 to 4,000 are roughly estimated. Thus the clouds account for a major share of the galactic mass.

However, as M. G. Edmunds, also of University College, points out, "the importance of the clouds lies not only in their being easily the most massive individual objects in the galactic disk, but also because they are regions of very active star formation." Dr. Edmunds was summarizing a workshop on the clouds held last August. Astronomers have only begun to understand the clouds, he explained. Important — and unanswered — questions are how the clouds form and how they resist the gravitational forces that should cause total collapse, yet allow parts of themselves to collapse to form stars. But despite the puzzles, he observed, "Giant Molecular Clouds have established themselves as a primary constituent of the galaxy, and their study will provide many clues in understanding the mechanism of star formation."

The clouds may illuminate the origin of life, as well. Five years ago, Arno A. Penzias of Bell Telephone Laboratories argued that carbon monoxide is a thousand times more abundant than any other interstellar molecule except hydrogen. Carbon, he remarked, "seems to play a disproportionately large role, even as it does in the things we have for lunch." David Buhl of the National Radio Astronomy Observatory and a pioneer molecule hunter speculated that organic chemicals could survive the collapse of a dust cloud into stars and planets. "The entire process," he said, "seems to be more than coincidental and suggests that the accumulation of the dust and molecules into planets and atmospheres, and even the subsequent evolution of life, may all be part of an astronomical evolutionary cycle of very long time scale." And in 1973, Gustav Arrhenius of the University of California and Richard Gammon of the National Radio Astronomy Observatory suggested that solar nebula seeded earth with life-forming chemicals.

Audacious Postulates

None of the theorists has been willing to go so far, or so fast, as have Drs. Hoyle and Wickramasinghe in developing the concept of the cosmic cradle. Basing their theory partly on their own interpretation of the infrared signatures of some space chemicals, they reject Darwin's warm shallow pond or Stanley Miller's and Harold Urey's lightning-created chemical mixtures as birthplaces of organic life. "The concept of primeval soup," Dr. Wickramasinghe remarked in an interview, "is just a confidence trick which people have bought without much critical analysis. It would be too dilute for anything to happen."

After studying the evidence for several years, the two astrophysicists are now presenting their ideas in rapid fire, mainly in talks and in the journals *Nature* and *New Scientist.*

They began last year with a report that they had identified cellulose-like molecules in the interstellar dust. "Without supporting evidence, this would seem a bold conclusion," they wrote. The evidence they marshalled was a reinterpretation of certain infrared spectra to show they could be matched to laboratory spectra of such materials as cotton. "We did a rough analysis with a pocket calculator," Dr. Wickramasinghe explained, "and the fit was so good we thought we had a case." V.I. Goldanskii of the Institute of Chemical Physics, U.S.S.R. Academy of Sciences, published a companion article in the same issue of *Nature* supporting their ideas. There he outlined a process by which he thinks formaldehyde (an interstellar chemical) turns into more complicated molecules such as cellulose.

Picking up a suggestion of Cornell University astronomer Carl Sagan, Drs. Hoyle and Wickramasinghe next explained how formaldehyde-derived molecules might be favored in interstellar evolution. The parent dust cloud may alternately expand and contract; when relatively compact and dense, even fragile molecules would be protected within it. But when the cloud expands and becomes thin, only tougher molecules could survive the increased ultraviolet flux. Cellulose-like structures, formed when the cloud was dense, would be most likely to survive.

The two astrophysicists have gone on to

venture the following conclusions of their still-developing theory:

☐ The evolution of inorganic matter into primitive biological systems is more or less continual in interstellar space — not sporadic on the surfaces of planets.

☐ Interstellar dust clouds, out of which stars and planets form, are the main site of this evolution. However, within a planetary system such as our solar system, comets condensed from the interstellar medium may provide a protected environment for further evolution. Such a comet may have seeded primitive earth with simple life forms.

☐ Comets may be bringing such life forms to earth today, perhaps unleashing epidemics or introducing viruses with novel genes that become inserted into the genetic structures of some of earth's creatures.

Heady stuff. And Dr. Wickramasinghe admits that "the reaction has mainly been skeptical." Yet, he says, "No one has pointed out any serious flaws [at least to the part of the theory about life evolving in outer space]." He adds: two years ago, "our ideas were highly speculative. But so many bits and pieces have fallen into place to make the story compelling. Nitrogen compounds, sugars, just the right chemicals that need to be brought together to start living systems, are being found. I am convinced that the chemistry of life is predetermined by interstellar conditions." Most impressive, he says, is identification of formic acid and methylamine, chemicals that can react to form the amino acid glycine. "If one amino acid, why not all 20 that go to make up proteins?" he asks.

In this connection, Dr. Wickramasinghe takes comfort in the fact that amino acids have been isolated from meteorites. The fact that they haven't been found on the moon, on the other hand, does not disturb him. Even though cosmic chemicals may be deposited there, he doesn't think they would survive exposure on the moon to proton bombardment and other intense radiation from the sun. In fact, this is one reason why he and Dr. Hoyle favor comets as the cosmic cradles of the solar system. Protected by an outer cometary shell, the evolving molecules would lie at a depth where heat produced by collisions or close solar passages would provide a liquid water environment. There viruses or even bacteria could form.

Many astronomers can follow the logic of Drs. Hoyle and Wickramasinghe a good way, at least as an intellectual game.

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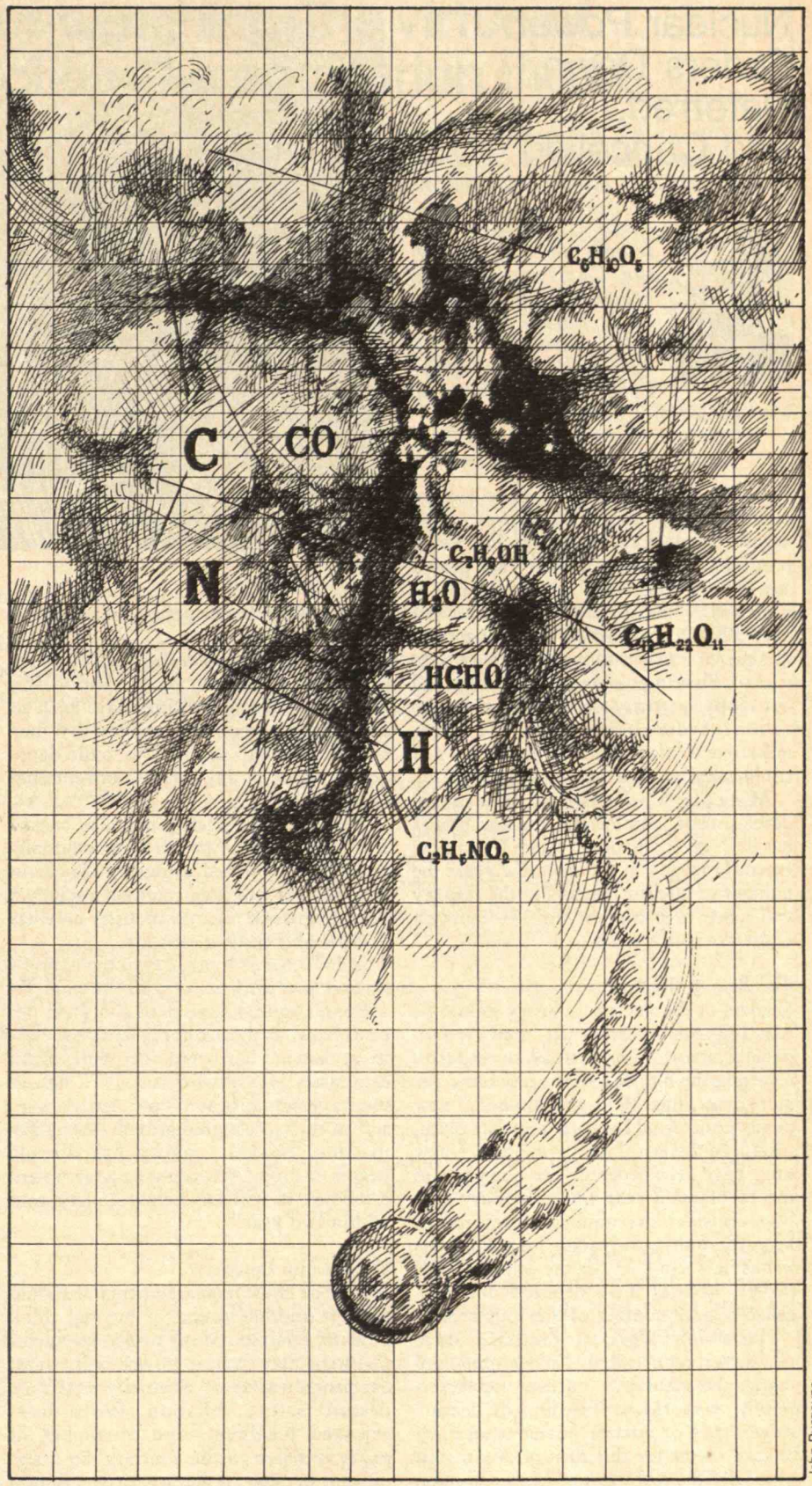
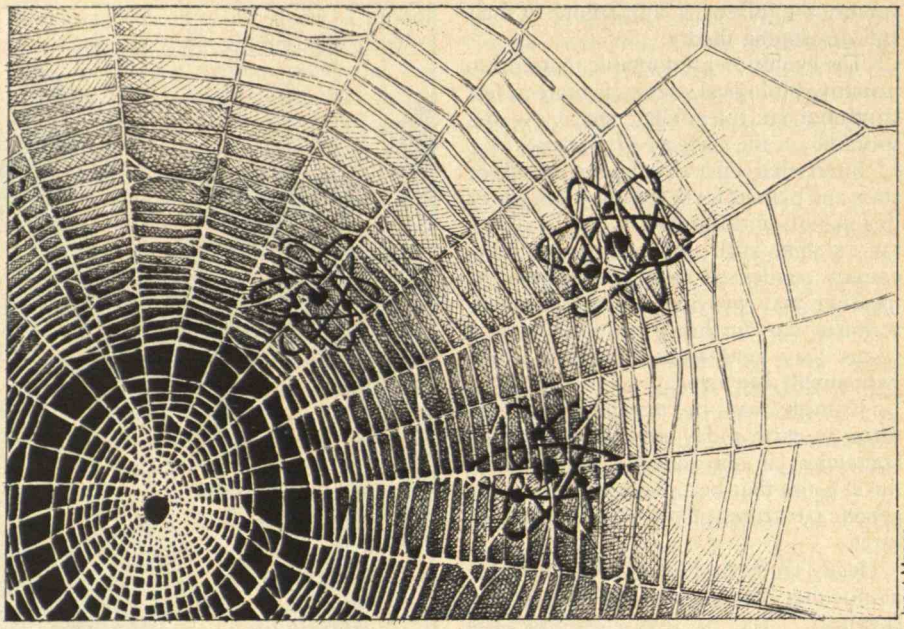


John Burgoyne

Nuclear Power: Orders Down, Deferred, and Cancelled

David F. Salisbury, who reports on science for the Christian Science Monitor *from its West Coast Bureau, is a regular contributor to the* Review. *He studied physics at the University of Washington (B.S. 1969).*



Janet Mager

Since President Eisenhower provided the impetus for harnessing the power of the atomic bomb with his Atoms For Peace program, the nuclear industry has grown steadily. Its assets are now estimated at nearly $100 billion, its employees number over 300,000, and its 67 operating reactors provide 12 per cent of America's electricity. Fission-powered plants churned out more electricity last year than did the nation's hydro-electric dams — a fitting milestone to mark the 20th anniversary of commercial nuclear power in the U.S.

Along the "S"-shaped path of industrial development, commercial nuclear power has built up to the point where it can now expand rapidly. In the next few years the number of nuclear reactors in the country will more than triple if the 156 units on order are constructed.

The Bite of the Axe

Leaders of the nuclear industry should be toasting one another in their wood-paneled boardrooms. Instead, the industry is feeling the bite of a sharp economic axe at its base. Since 1973, the number of new plants contracted for each year has plummeted. In the last three years only 11 new units have been ordered. This compares to the 16 plants a year which industry analysts consider the minimum required to keep the four U.S. reactor manufacturers in business. And besides the dearth of new orders, utilities have deferred and cancelled a large number of previous orders.

Nucleonics Week, a respected trade newsletter, reports that, "In the opinion of many, the giant U.S. nuclear industry is slowly, very slowly bleeding to death." Adversaries of nuclear power would like to take credit for this turn of events, but primarily the turbulent energy economics of the post-embargo period are responsible.

Ironically, the increasing price of petroleum should favor the nuclear option. But the nation's electric utilities have been so weakened by economic recession that they lack the capital required to build large power plants of any sort — conventional or nuclear.

The economic decline has also caused electricity growth rates to be substantially lower than predicted. Because utility plant construction was predicated on a steady 8 per cent growth rate, the industry now has considerable reserve capacity.

In 1970, reserve capacity of the nation's utilities was 22.5 per cent of the total. By 1976 this figure had risen to almost 45 per cent. Now, as the economy recovers, electrical demand has begun increasing again at a faster rate. Preliminary 1977 figures put its growth rate at 5.7 per cent. As a result of this accelerated growth and utility inaction, reserve capacity has already begun to drop. According to government estimates, it will fall below 25 per cent within two years.

Decline and Inactivity

Sooner or later, increased demand should prompt another round of buying, think industry analysts. Many utility executives maintain that nuclear power is the least expensive source of electricity available, despite severe inflation, lower-than-expected reliability, and a number of paper analyses to the contrary. So a significant number of the new orders should be nuclear.

But the reactor vendors may not be able to respond to a surge of orders, following these years of decline and inactivity.

Westinghouse, for example, dominates the vendor industry and has a $5.5 billion backlog to keep its reactor division busy for several years, says Joseph Rengel, a company spokesman. But after the work is completed and if no new orders are placed, Westinghouse (which has yet to show a profit on its nuclear business) would have no choice but to disband. The three other reactor vendors are in similar positions.

Anti-nuclear forces aren't troubled by this state of affairs. They argue that conservation coupled with increased reliance on coal can eliminate the need for more nuclear power plants. The nuclear industry, on the other hand, warns that increased American dependence on imported oil in the mid-1980s is likely to result if nuclear power isn't encouraged. And Jack O'Leary, Assistant Administrator of the Department of Energy, calculates that failure to "revitalize" the nuclear option could cost the U.S. an additional 10 million barrels of imported oil per day by the year 2000. □

Doughnut-watching•The virtue of dissatisfaction•The egalitarian thrust

When it comes to evaluating the performance of the American economic system, it's hard to get some people to look at the substance. They get so hung up on shortcomings that they fail to discern accomplishments. Instead of comprehending the doughnut, they become fixated on the hole.

As a result, they come out almost totally negative and conclude that we ought to scrap the whole system and rebuild from scratch. In our view, this ignores the extraordinary benefits that our system—perhaps best called "democratic capitalism"—has produced for the ordinary person over the years. It also ignores the question of what to substitute for the most dynamic, most egalitarian, and most productive system in history, despite all its obvious flaws.

We don't feel any theological attachment to the American economic system. Certainly it can be improved. And this is exactly the point: The system has improved throughout the past 200 years, no matter how unevenly, is still improving, and seems likely to keep on improving if given a chance.

The best way to gauge any system's improvement is, of course, to monitor its performance.

If you look only at the hole, you'll find that both unemployment and inflation in the U.S. are still far higher than any of us would like.

But if you look at the doughnut over the 10 years through 1977—a decade that encompassed the Vietnam war, the oil embargo, and other afflictions—you'll find this: The number of people employed in this country increased well over twice as fast as our population did.

And, as Ben Wattenberg points out in his book *The Real America*, family income in the U.S., after adjusting for inflation, has doubled in a generation, and the steady upward movement of median family income in our country has created a "massive majority middle class... something that has never happened before anywhere..."

This is not to say any of us should be complacent. On the contrary, healthy and informed dissatisfaction with the status quo has underlain much of our country's progress. But this constant progress itself has created problems: By performing economic miracles, the system has created enormous expectations and a growing desire for instant gratification of those expectations.

The key to this dilemma is partly one of timing: Our system is indeed able to work wonders when it is allowed to operate within rational, realistic timetables for change and with minimal government intervention. The problem often lies in expecting too much too soon, and this in turn often leads to well-meaning but misguided government intervention, which does more harm than good.

Most of the critics of our system agree that it is wondrously productive, though they are reluctant to comprehend that material wealth is indispensable if a society is to support such essentials as health care, education, and other social services. They fault the system on "moral" or other grounds—including, sometimes, esthetics. And they focus disproportionately on the short-term malfunctions that punctuate the system's long-term performance.

At least part of the carping at our economic system is sheer intellectual faddism; it's easier to criticize than to learn the basics of economics, which can require one to overcome deeply rooted biases. Many elitists seem to feel that in the long run our country will be better off if the decisions are made by a select few rather than by the masses of people. Since our economic system is essentially egalitarian in its thrust, elitists often appear to fear and distrust it.

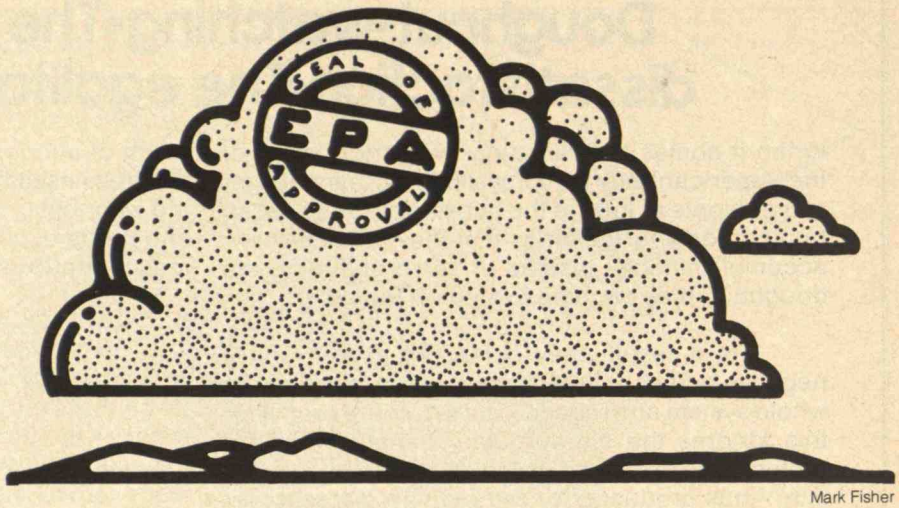
Being egalitarian, the system naturally develops a constituency that is large and loyal, even if not as vocal as those bent on remaking society in their own image. If left unchecked, this tendency of people to think for themselves will almost inevitably strengthen both our economic and political systems.

This is a prospect we find it easy to live with. We believe that over any reasonable period of time the American people, no matter how much they criticize their economic system, will devote themselves more to appreciating the doughnut than to denouncing the hole in it.

Mobil®

Flaws and Failures of the Clean Air Act

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. in Physics is from Cambridge University.*



Mark Fisher

Every year thousands of people die prematurely from heart and lung conditions aggravated by air pollution; millions suffer from emphysema or asthma; tens of thousands suffer from chronic bronchitis; hundreds of thousands of children suffer excess respiratory infections; tens of millions of working days are lost; and the costs of lost productivity and health care run into billions of dollars. The exact relationship of all these effects to air pollution is still controversial, but a thorough review by Lester B. Lave and Eugene Seskin in *Air Pollution and Human Health* (Johns Hopkins University Press, 1977) shows a number of rather convincing correlations between mortality, morbidity, and various measures of air pollution.

Yet the federal Clean Air Act has been implemented and amended so that relief from these heavy burdens cannot now be expected for many years, if at all.

When the Clean Air Act was amended in 1970, it laid out an ambitious program to restore the nation's air to a healthful quality by 1977. The Act's strategy was to establish national air quality standards for all the major air pollutants: particulates, sulphur oxides (SO_x), nitrogen oxides (NO_x), oxidants (ozone and peroxyacl nitrates), and hydrocarbons. The air quality standards were to be based on scientific knowledge of health and environmental effects, and were to be set at levels that would ensure the absence of significant adverse effects. The standards were to be enforced by the states, with national emissions standards to be imposed progressively for automobiles and major sources such as power plants. Special standards were to be established for hazardous toxic pollutants. The goals of the plan were admirable, the procedures straightforward and scientific, and the timetable clear; the costs were recognized to be high but were regarded as reasonable and acceptable. Why, then, did the plan not work? Why is the air still polluted?

Which Pollutants Are Worst?

In addition to its failure to regulate indoor air pollution (often much worse than outdoor air pollution), the Clean Air Act of 1970 had a number of major flaws. In the first place, it probably set out to control the wrong pollutants. Particulates, for example, come in many shapes, sizes, and chemical forms: E.P.A.'s choice of total suspended particulates (TSP) as an index of air quality was not adequate to reflect the full range of toxicity of different types of particle. It is fairly easy to reduce levels of TSP by controlling emissions of large particles (smoke), and this approach has been worthwhile. But it has had little effect on concentrations of small (submicron) particles which are often more irritating or toxic. For example, sulphur dioxide is not very toxic *per se*: most of its health and ecological effects are manifested in conjunction with particulates, or after it is oxidized to sulphuric acid or various sulphate salts. Clearly, measuring SO_2 is merely a convenient shorthand for measuring a complex of hazardous pollutants: meeting the national air quality standard for SO_2 will not ensure healthy air. Nor do we yet understand all the interactions of nitrogen oxides, hydrocarbons, and sunlight to form photochemical smog.

As we become aware of the complexity of air pollution chemistry, our confidence in air quality standards diminishes. If we are not measuring the pollutants which actually have adverse effects, we cannot be sure that they remain below critical levels. And even if we can identify the critical pollutant, the old-fashioned idea that there are threshold levels below which there will be no harmful effects continues to be argued. But if a large number of people are already sick, no sound theoretical reason exists to prove that they can tolerate *any* increase in pollution.

Implementation was difficult as well. Some states were slow to formulate plans; many lacked money and expertise; almost all lack capability for monitoring and enforcement. The state plans that were established focused on the largest point sources; comparatively little can be done to control domestic and dispersed pollution sources. Even the casual observer can see that apartment houses flare their furnaces with impunity; that many factories release pollutants at night and on weekends; and that untuned automobiles, trucks, and aircraft violate visible emissions standards.

Foot-Dragging

Most serious, however, is the failure of major polluters to reduce their emissions on schedule. The automobile industry, for example, has repeatedly requested and obtained extensions of the mandated deadlines for reducing exhaust emissions. It is hard to know whether the industry's failure to meet the deadlines is due to incompetence, intransigence, or both. The automobile manufacturers initially detuned their engines and then started to hang heavy, expensive, inefficient catalysts onto the exhausts. Only after making these poor technical decisions did they start seriously to redesign the engines to improve combustion efficiency. As a result, the industry repeatedly claims that it cannot meet the national standards — although it is somehow able to meet them in California. The industry claims — with some justification — that the timetable for re-

ducing emissions puts it under extreme pressure. But it is all too obvious that foreign manufacturers succeeded where the U.S. manufacturers failed.

The same resistance was displayed by the utility industry in reducing its emissions. Adequate control of SO_2 emissions from plants burning high-sulphur coal or oil requires the use of stack gas scrubbers, and this led the electric utilities into the unfamiliar enterprise of large-scale wet chemical engineering. While the largest utilities fought the regulations bitterly and won years of delay, some small companies installed scrubbers successfully while others built plants that proved costly failures. Even after years of development, it is still not clear that scrubbers can be made to work on an industry-wide basis. Some pin their hopes for SO_2 control on advanced combustion techniques, but even if these are successful, the large-scale burning of coal is likely to provoke serious regional pollution by nitrogen oxides.

It is easy, of course, for a critic to be wise with the benefit of hindsight. The Clean Air Act has had some notable successes, and without it the air would undoubtedly be much worse than it is now. However, the engineering failures, the hard-won delays and waivers, and the slipped deadlines of the last eight years do no one credit. The U.S. record in abating air pollution suffers in comparison with that of Japan, where industry and government accepted a common goal.

In one respect, however, the Act has taken root and grown an unexpected flower. The 1970 amendments argued that the Act's purpose was to "restore and maintain" the quality of the nation's air. Whatever Congress may have intended by this vague phrase, it was interpreted by the Supreme Court to mean that air quality could nowhere be allowed to become worse. The doctrine of "no significant deterioration" abruptly threatened to bring to a halt all new industrial development in large areas of the country where air quality standards were not being met. Faced with this politically disastrous prospect, E.P.A. in 1976 devised an "offset" policy: a polluting company wishing to locate in an area of non-compliance might do so if it could persuade another polluter in the area to reduce emissions by a larger amount. (A successful example was Volkswagen, which was able to locate a new assembly plant in Pennsylvania by persuading the county to reduce hydrocarbon emissions from its road maintenance operations.) The offset policy has significant implications. It has for the first time brought pollution control into the marketplace, allowing an expanding company to buy another institution's "license" to pollute (which hitherto has been granted freely by the government). Economists have long claimed that the regulatory-enforcement method of pollution control is inefficient and ineffective; here perhaps, is the chance to test whether they are right.

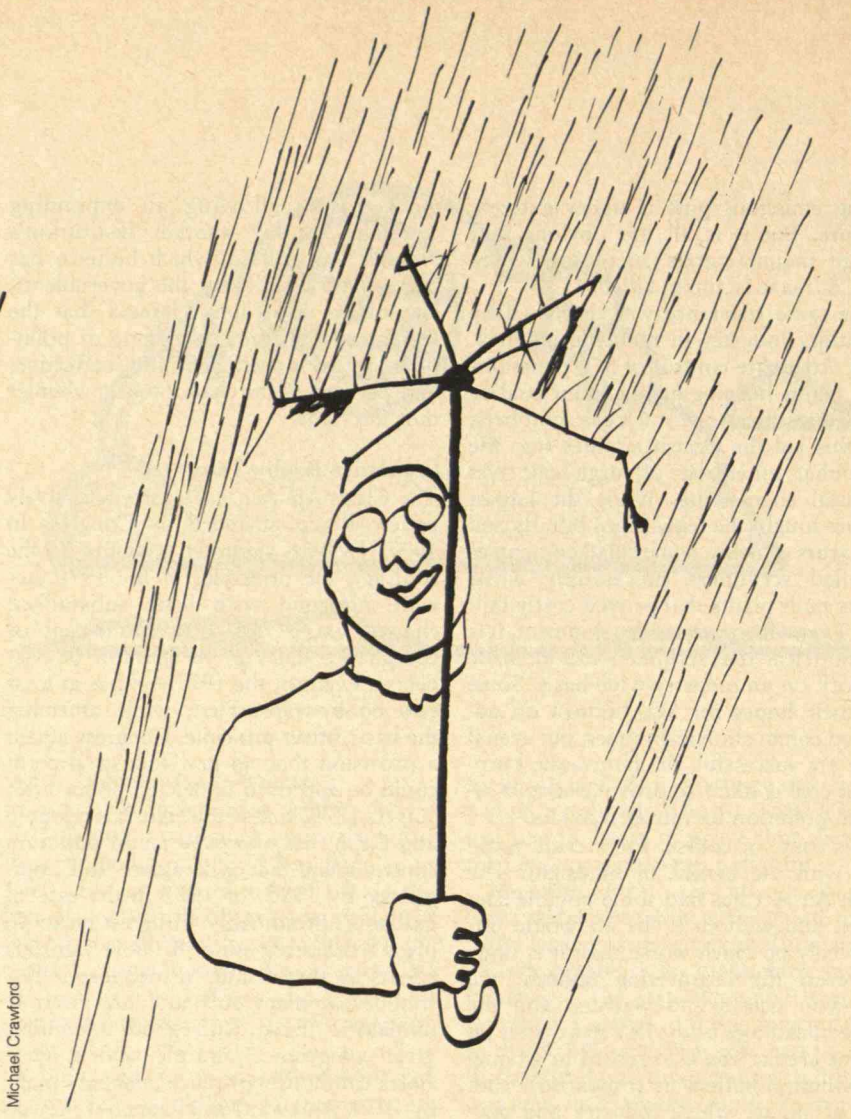
Legislative Booby-Traps

The Clean Air Act was again extensively reviewed and amended by Congress in 1977. Despite vigorous attempts to the contrary, the principles of the 1970 Act were affirmed with little substantial change, except for a postponement of compliance dates in recognition of past delays. Even so, the 1977 Act has at least two booby-traps. First, while affirming the basic offset principle, Congress added a provision that no new industrial plant could be approved under the policy after July 1, 1979, unless the state has adopted and E.P.A. has approved an air pollution control plan that will assure full compliance by 1982 (or 1987 in the case of oxidants). Presumably, Congress meant to press recalcitrant states to more vigorous efforts by threatening to foreclose industrial development. Such an intent is surely unrealistic. Even with good intentions, great competence, and plenty of money, states can hardly produce adequate plans by 1979. And what will happen if they do not? Politically, E.P.A. can no more be expected to halt industrial expansion in major states in 1979 than it could in 1976.

Moreover, Congress has cynically sabotaged its own booby-trap. At the same time that it required compliance with ambient air quality standards by 1982, it postponed requirements for new automobiles to meet emissions standards until 1981. As a result, emissions cannot be substantially reduced for a number of years after. So the standards will not be met by 1982, unless Congress intends E.P.A. to enforce traffic reductions of 50 per cent and more in many major cities. Surely, what will happen is that the 1982 compliance date will slip again. In the mid-1980s, people will still be dying and gasping for breath, and the Clean Air Act will be more hollow than ever. □

Popular Madness: Delusions of Disaster and Scarcity

Mark Rollinson is a lawyer practicing in Washington, D.C. His essay is adapted from a speech to the Corporation Section of the New York Bar Association.



Michael Crawford

Almost everyone has a book which he cherishes above all others — which upon every reading is still a delight. One of my favorites is *Extraordinary Popular Delusions and the Madness of Crowds,* written by an English lawyer, Charles MacKay, and first published in 1841. My edition is labeled "Volume 1"; I do not know whether any other volumes were written. Volume 1 was copyrighted in the U.S. in 1932 and is now in its 20th printing.

Mr. MacKay narrates from excellent scholarship. The chapter headings are so intriguing that one hardly knows where to begin: The South-Sea Bubble; Tulipomania; The Alchymists; Fortune Telling; Influence of Politics and Religion on the Hair and Beard; The Crusades; Witch Mania; Popular Admiration of Great Thieves; the list goes on and on.

Delusions of the past are sometimes amusing, sometimes embarrassing, but almost always fascinating. In the present, however, popular delusions are virtually impossible to discuss calmly, no matter how sophisticated the parties. For example, it takes little study to realize that dramatic change is an integral part of the history of the world. Living species come and go. Continents shift. Mountains erupt. It would require arrogance beyond that of a Wall Street lawyer to assume that at this moment the ideal balance in nature has been struck as compared, say, to the Ice Age, the Age of Dinosaurs, or some other period. Yet most of us speak of the "delicate balance in nature" as a given and the mere suggestion to the contrary arouses strong emotions.

Delusions Past and Present

Past and present delusions are more easily illustrated by parallel examples. The long bow was invented at least 100 years after Roger Bacon's discovery in the 13th century of the marvels of gunpowder. By the 15th century gunpowder was still little used but the long bow was flourishing — so much that it had been outlawed by papal edict. A popular delusion of the day was that the long bow was the ultimate weapon. It could be fired rapidly — about 12 per minute — with an effective range of some 200 yards. The natural supply of ammunition was limitless. Any enemy with persistence could wipe out the entire civilized world. And if all sides were so armed, after a mere few days of intensive activity there presumably would be no one left on earth save a last single archer.

Numerous attempts were made by treaty to eliminate the long bow as a permissible instrument of war. By the 17th century these intensive efforts met with success. By remarkable coincidence, improved firearms and improved quality controls in the manufacture of saltpeter had made guns more effective weapons and gave the pope a new ultimate weapon to outlaw. A new popular delusion was born.

These delusions of the past are easy to recognize today. Now let's turn to a more complicated but parallel delusion of more recent vintage.

In the late 1950s it was generally believed that a massive nuclear holocaust would kill nearly everyone on earth. Then Herman Kahn astounded us with his enormous text, *On Thermonuclear War,* in which he explained that in the event of the worst conceivable nuclear holocaust, roughly 90 per cent of all living persons would die within two weeks. He suggested, however, that in the worst event some 10 per cent would die from blast or direct radiation and some 80 per cent from gamma radiation — "fallout" — over roughly a two-week period. He hypothesized that if everyone could be within 20 minutes of a fallout shelter (not a blast shelter) stocked with two weeks' provisions, only some 10 per cent of the population would die in the worst conceivable nuclear holocaust and some 90 per cent would emerge from shelters into a reasonably habitable world.

Contracts were let immediately to various think tanks around the country to test Dr. Kahn's analysis. I happened to be involved with one such effort. We concluded, as did all the others, that Dr. Kahn was right. We concluded further that the cost of a shelter program compared extremely favorably in absolute terms with

the then-anticipated costs of a massive missile intercept program. On a human life basis, the comparison was even more favorable since an intercept program — if successful — would save only the immediately roastable 10 per cent of the population. The fallout would come anyway and kill some 80 per cent depending on weather conditions.

President Kennedy was persuaded by the logic of a fallout shelter program and a well-funded public education campaign began. It failed. Many argue that it failed because the popular delusion of the necessary finality of nuclear war could not be dispelled, despite vigorous and persistent efforts of a revered national leader.

Presumably the fallout story arouses stronger reactions among more people than the long bow account, thus illustrating that current delusions are more difficult to discuss than delusions past.

The World as Sugar Bowl

A delusion that has persisted in the western world for more than 300 years without substantial change holds that wealth — in the broad sense of the resouces of earth, jobs, food, physical and cultural comforts — is limited. Therefore rationing, reallocation, and conservation are essential to the survival of the human race, or at least to equable enjoyment of life by our last few generations. This delusion and its corrolaries — what I shall call the sugar bowl view — has perhaps greater impact than any other in history; most of us embrace the belief to this day.

A corrolary of the sugar bowl view is the "jobs syndrome." In 300 years the increase in productivity as a result of automation in the western world has been staggering. In 150 years the western world has gone roughly from 90 per cent agricultural occupations to the mere complement of that number. Not only have jobs not been lost, but also the variety of careers available has increased exponentially, leisure time for other pursuits has increased dramatically, and the wealth of man — in the broad sense of health, knowledge, and physical well-being — has continually increased beyond our imaginations.

It hardly seems possible that anyone having more than a passing understanding of the history of the industrial revolution and the agricultural revolution could seriously believe that increases in productive efficiency cause loss of jobs. Yet the conviction persists. For example, two bills have been proposed in the Maryland legislature: one would prohibit self-service gasoline pumps; the other would prohibit automatic checkout procedures in grocery stores. The principal agruments in both cases are that jobs are in jeopardy.

Featherbedding and barring of automated equipment are hallmarks of many powerful unions. Many state and federal programs are judged almost solely on a basis of maximizing the number of jobs created rather than on the more rational basis of maximizing productivity per job. In short, despite centuries of proof to the contrary, the jobs syndrome corrolary of the sugar bowl delusion is still with us.

Probably the jobs syndrome persists on the evidence of common sense. The world is indeed sort of flat in the near vicinity of each of us. And, in the very short term, some jobs are "lost" in the process of improving productivity.

An even touchier corrolary of the sugar bowl delusion is the "scarcity" syndrome.

The Club of Rome observed a few years ago in its *Limits to Growth* report that there were but ten years of petroleum reserves yet available to mankind unless we mend our ways. Subsequently, and in a much less widely read report, the Club observed that there had been only ten years of foreseeable petroleum reserves in each of the past 50 years; this phenomenon appeared to be caused not by scarcity but by the economic reality that it only seems prudent to prove reserves some ten years in advance.

Nonetheless, the popular delusion persists that we are running out of energy, the end may be near, and conservation is critical. Major companies conduct advertising campaigns to publicize how much energy they're saving in the public interest. A mammoth bureaucracy has been created to promote conservation.

Meanwhile, a host of substitute technologies and fossil fuel sources stare at us, limited in development only by the businessman's fear that O.P.E.C will lower the price of crude. Yet the delusion of scarcity persists.

Still another corrolary of the sugar bowl delusion is the "redistribution" syndrome. We speak of unfortunate disparities in incomes among individuals, states, coun-

Continued on p. 19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Ever wonder about * and

With * and #, new telephone services will soon be at your fingertips. These services will be possible because technological innovations from Bell Laboratories and Western Electric are transforming the nation's telecommunications network.

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At the heart of each ESS is something called stored-program control. With it, the system's calls are controlled by coded instructions, stored in a memory and executed by a central processor. New features can be added by updating the stored instructions rather than rewiring or making complex equipment changes.

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These innovations are possible largely because of advances in solid-state electronics. Because of their decreasing cost, low power consumption and speed of operation, today's integrated circuits are enabling engineers to design more capability into communications systems at lower cost.

Building on Bell System accomplishments such as Direct Distance Dialing, digital communications and high-capacity transmission systems, modern electronics permits the new network to handle a wide variety of communications needs.

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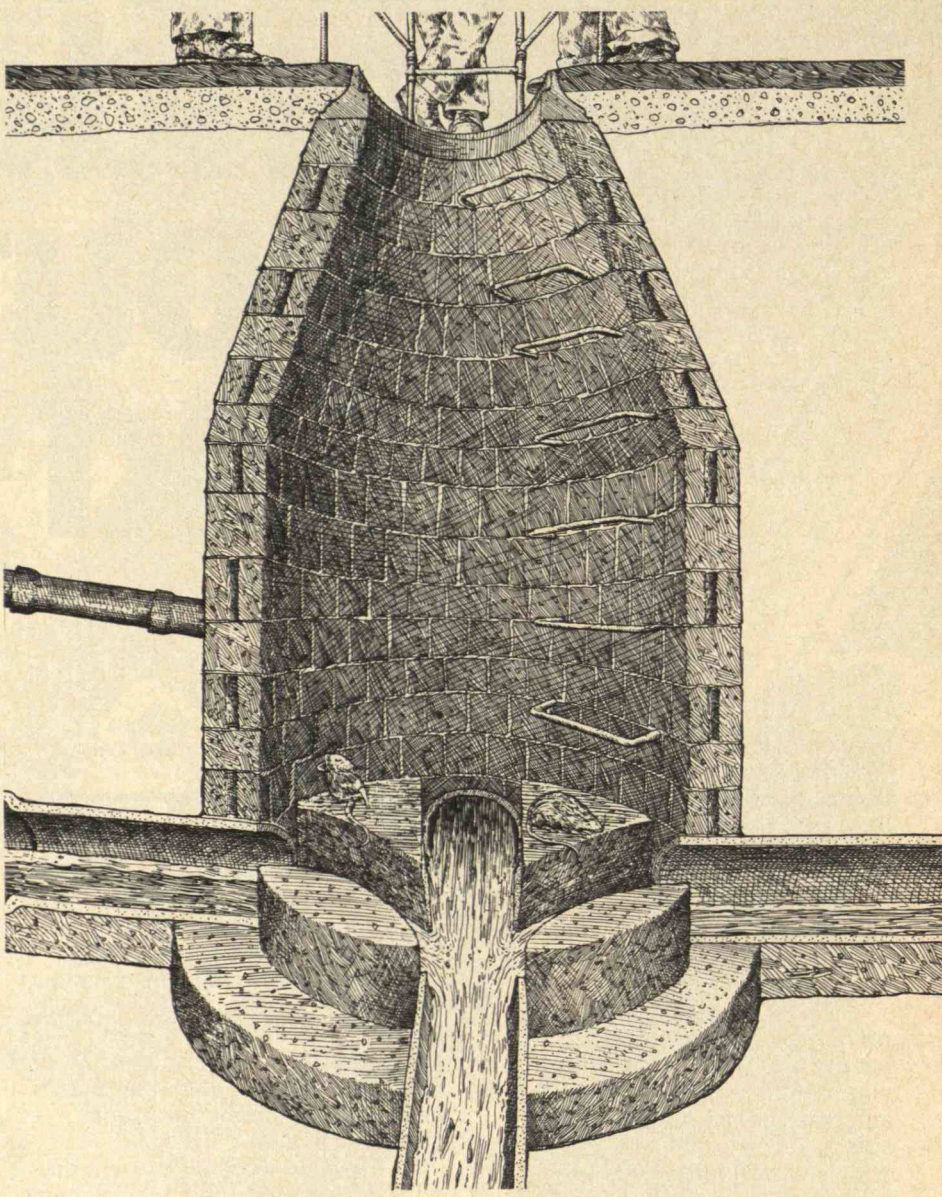
Sewers and Urban Growth

Land Use and the Pipe
Richard D. Tabors, Michael H. Shapiro, Peter P. Rogers
Lexington, Mass.: Lexington Books, 1976, xvii + 183 pp.; no price

Reviewed by Robert Nelson



American cities have been shaped in the past by their transportation systems. Although sewage treatment has been as necessary for development, the availability of sewer facilities has not significantly constrained growth. Real estate developers have been willing to install smaller sewer lines themselves to tie into interceptor lines and treatment plants. And these larger facilities have typically been provided when needed to accommodate development pressures.

This situation has changed in recent years. A number of municipalities seeking to impose tight controls on growth find that limiting the availability of sewer systems is an effective strategy. A number of planners and land-use students are also proposing that sewer provision be used to influence the timing of development, since zoning frequently proves too feeble a tool to accomplish this purpose.

Controlling Development with Sewers

Land Use and the Pipe is a primer on sewer system design for urban planners and others who seek to guide growth. The book describes the engineering considerations involved in sewer system design, financial analyses used in selecting among alternative designs, and the general role of the sewer system in development. Most important, it observes the relation between sewer system design and population projections. These projections determine the capacity that will be built into individual segments and the whole sewer system. Since the projections may well be self-fulfilling, the planner had better take care to participate in — perhaps even direct — their formulation.

Once population projections have been fixed, an engineer must design the system. But for those who may be interested in the engineering guidelines and financial analyses employed in sewer system design, *Land Use and the Pipe* provides a brief and understandable explanation.

However, the most important question remains unexplored: should sewer installation be used to control urban development, or should facilities be provided to accommodate development as it occurs? The authors clearly reject this latter approach. They regard as self-evident the theses that public land-use plans should guide urban development, and that sewer system installation — together with zoning regulations — should be employed to implement the plans.

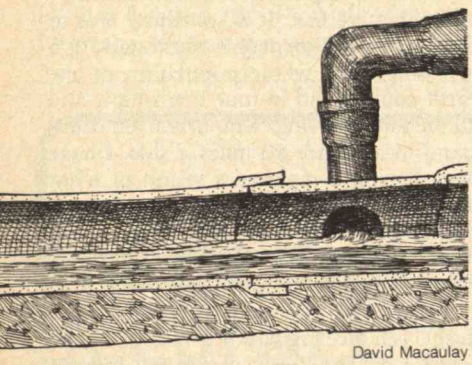
The problem is that in the U.S. almost all formal planning and implementation is local. Thus planning has tended to promote local against wider interests. For example, restrictive local zoning practices have been defended with the assertion that they were based on a "comprehensive plan."

Creating institutions with regional or even broader authority for planning and land-use control could remedy this situation. But such institutions have been proposed for years with almost no success. The American public has had insufficient faith in centralized authority and has placed too great a value on local autonomy. And the results of formal planning at the local level have not inspired confidence in a centralized planning authority. Local planning has had symbolic significance — especially in satisfying legal prerequisites for zoning ordinances and for receipt of federal funding — but not much real impact. The chronic ineffectiveness of local planning suggests serious inadequacies in planners' assumptions and tenets.

A New Property Right

The authors of *Land Use and the Pipe* see sewage facilities as a new instrument to give communities tighter control over growth than has been afforded by zoning alone. They are well aware that restrictions on sewer availability could be used to serve narrow local interests, and disavow that purpose. But the only protection they offer to the contrary is the guidance of land-use planners. In light of planning history, it may well be preferable instead to maintain the more traditional approach to operation of sewer systems, and to install sewer facilities in response to development pressures. Accommodation of these pressures at least assures that the needs of the region, state, and even nation will be reflected in the community's development.

The role of planning in determining proper land use is significant for zoning



David Macaulay

policies. Zoning is less an instrument of planning as originally intended than a pragmatic mechanism — functioning much like the collective property rights of condominium owners. Zoning gives residents of neighborhoods and communities a similar right to control their environment. Zoning has worked as an incentive to build and maintain neighborhoods and communities of high quality — a consequence not much recognized. Another consequence receiving much more attention is zoning's promotion of social inequality.

Zoning, as sewer provision, could be an instrument for community good. We might force zoning to work as prescribed in zoning and planning theory. This strategy would require revising planning concepts, channeling greater resources into public planning efforts, and taking strong steps to ensure that zoning is administered in accordance with plans. Or alternatively, we can accept that zoning is effectively a new collective property right and useful in many respects. In that case, we must decide what changes brought about by zoning should be encouraged, and what might better be reversed.

The task is not to make planning succeed, but to design property-right institutions that foster desirable patterns of development in response to private pressures.

Robert Nelson is a member of the Office of Policy Analysis, U.S. Department of the Interior. His book Zoning and Property Rights *was published this fall by M.I.T. Press.* □

Rich Man, Poor Man

Beyond Dependency: The Developing World Speaks Out
Guy F. Erb, Valerina Kallab, eds.
Washington, D.C.: Overseas Development Council, 1975, ix + 238 pp.; $3.95

Reviewed by Larry D. Spence

The problems of the poor nations of Asia, Africa, and South America appeared possible, if not easy, to solve after World War II. The general strategy was to overcome the industrial weakness and social instability of these countries by promoting economic growth. Improved economic performance, measured as growth in GNP, was expected to lead eventually to more equitable societies with democratic governments. The strategy was one of encouraging these southern nations to imitate their northern neighbors by means of foreign aid, foreign investment, and the transfer of technology.

The scheme didn't work. Surveys in the early 1970s indicated that the poorest segments of these countries had been hurt rather than helped by economic development. While GNP growth rates of 5 per cent or more were achieved in many cases and while extensive transfers of technology did take place, development was accompanied by acute unemployment, lowered standards of living for the poor, higher standards for the rich, and increasing technological and economic dependence on the rich nations. In many poor countries the theories of economic development on which this strategy was based became the object of derision and the post-World War economic order appeared to be a diabolical system of neocolonialism.

A Strategy Gone Awry

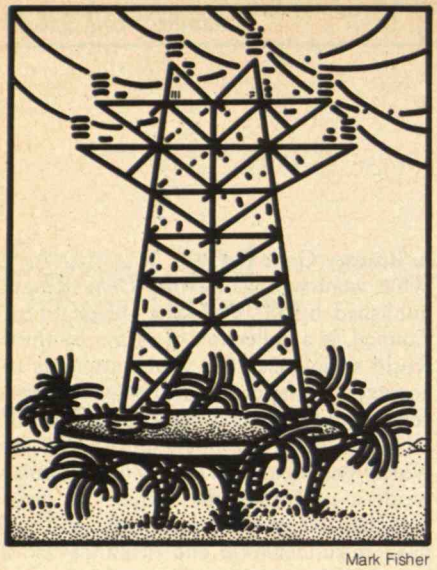
What went wrong? *Beyond Dependency,* published by the Overseas Development Council, is a collection of essays by third world social scientists which attempts to analyze that failure and to offer the conceptual basis for a new development strategy. It is an important book for North Americans to read: our popular wisdom attributes the failure to overbreeding or ethnic incapacity, and we have misunderstood the demands for a new world economic order by third world nations, when we have heeded them at all.

Third world countries reject the patterns of industrial development which the affluent nations largely take for granted. Their rejection is often deemed irrational. But the authors of these essays are careful to present the reasons for that rejection and to explain why the capital-intensive, skill-displacing, and centralized technology of the rich, northern nations is unsuited to the needs of the impoverished world below the equator. And they sketch an alternative development strategy based upon national self-reliance and international equality.

An underlying assumption of the nine authors is that purely economic theories of development fail to provide useful guidelines for policy decisions. As one author, Soedjatmoko of Indonesia, writes, ". . . it has become obvious that development is not so much economic growth as it is the cultivation of the capacity to grow — the capacity to respond creatively to new challenges."

According to the old strategy, development could be achieved by importing technology to foster reliance on domestic manufacture rather than imported commodities. Technology was purchased in various forms: equipment, patents, technical know-how, hired specialists, or the completely packaged investments of multinational corporations. But this technology reproduces rich-country consumption patterns which are too costly and inappropriate to the material needs of developing nations.

Felix Peña of Argentina points out that the third world policy of import-substitution encouraged governments intent on rapid industrialization to offer inducements for investments by multinational corporations. Constantine Vaitsos, of the Andean Common Market, notes that corporations have catered to affluent consumers at the expense of basic human needs. This is not the result of callousness, he argues, but because those corporation's products and plants are geared to the markets of advanced industrial nations. A



Mark Fisher

commodity that multinational executives consider efficient, modern, or the latest thing may be inefficient, regressive, and useless in the context of a third world society.

But by catering to wealthy consumers, foreign investments have resulted in a series of negative impacts on third world economies. Such investments attract scarce local technical talent and resources to the production of luxury goods. The imported technology depends upon large capital outlays and substitutes machines for labor even as over-all production expands. Problems of unequal income distribution are accentuated as the elites who work with or for the foreign corporations earn enough to adopt the living standards of their wealthier western colleagues, while the poor suffer higher rates of unemployment.

As a result, today nearly every poor nation can show visitors new industrial plants and modern cities amidst choking shanty towns and slums crippled by a desperate and hopeless poverty.

Not a Dole but an Investment

According to third world observers, the hope that rapid economic growth initially benefiting the few would "trickle down" to the many has proven a pernicious delusion. Therefore, the critics have rejected economic growth as the first priority and import-substitution as the most expedient policy. Instead, they insist that social justice should come first and that a policy of self-reliance should guide investment and technology transfer.

Samuel Parmar of India reports that attempts are being made in the poor countries to formulate theories of development based on their own socio-economic realities. To begin, Mr. Parmar argues that social justice, rightly understood, is not a dole but an investment in increasing a country's technical capacity. For as many observers have pointed out, the human beings of the third world are its most important resource. Without people who are educated, organized, disciplined, and motivated, natural resources and imported machinery remain only potential elements of development. All development policies must be directed to improve the lot of the least privileged, Mr. Parmar argues.

Self-reliance requires the capacity to generate technology, proliferation of economic power throughout society, utilization of local resources and talents, and the encouragement of public participation in the development process. The goal is not autarky, but the establishment of more egalitarian patterns of international economic relationships. As Mr. Peña states it, self-reliant industrialization ". . . makes it possible to acquire the ability to influence actively the most vital international decisions."

Several of the authors believe that a decentralization of the world economy to increase the third world's share in manufacturing activities would inaugurate a new international economic order. This new order would embody the transition, Ali Mazuri writes, ". . . from an interdependence based on hierarchy and Western charity to an interdependence based on symmetry and mutual accountability." Most of the authors are cautiously optimistic about the prospects for achieving this new order. But several note that the "ceaseless pursuit of affluence" must end among nations and that the world can ill-afford any more economic systems like that of the U.S. Thus, the changes in development strategies introduced in this volume imply changes in the patterns of consumption and production in our own nation.

Technological Politics

The dissatisfaction expressed in these essays and in the many available case studies of failed development projects indicate a basic flaw in our ideas about technology. What Arnold Pacey has elsewhere called a "new discipline" is needed if the technological problems of affluent and poor nations alike are to be addressed with any chance of long-term solutions. This new discipline I would call the "politics of technology." Its fundamental premise is that we must not accept technologies as simply given.

Since any technology is a human creation and therefore imperfect, it is a proper subject for public debate and criticism. And if criticism is to direct eventual improvement, then we must understand that the social problems associated with technologies are not caused by the way machines are used, but by the way they are designed. The question is — not, "What possible negative effects can we expect of this device?" Instead, we need to ask, "Is this machine or product designed to contribute to the quality of life of this community?"

The processes of technological design and development ought to be subjected to political control. The task requires that we re-think the purposes for which machines and productive processes are designed. The present over-riding purposes — products without worker, wealth without work — have proven pernicious to the species. As Sigfried Gideon wrote 30 years ago, the new purposes must be subordinated to human needs.

Larry D. Spence is Assistant Professor of Political Science at Pennsylvania State University.

Boulding

Continued from p. 4

peaks be 4,267 m.? The kilometer always strikes me as a niggling unit; driving through Europe one knocks off kilometers much too fast.

Babies by the Mile

When it comes to square measure, I am not sure that I would defend an acre vigorously over a hectare, never having plowed either. But I might argue for the roomlet (100 sq. ft.), the houselet (1,000 sq. ft.), and the big lot (10,000 sq. ft.). The township (36 sq. miles) is almost exactly a billion square feet. It is somehow nice to think that a billion people could stand in a township. The whole population of the earth could stand in four townships, and all the human beings who ever lived could stand in a square 50 miles a side. I have been having a nightmare vision of what this crush would look like viewed from the mountain above Boulder, with everybody ranged in order of birth and a 50-mile row of babies added every day.

Volumetric measure is tricky. The bushel is a nice big basket and a lot can be said for it. The liter is awkward. I prefer the smaller teapot. But here again a "roomlet" of 1,000 cu. ft. is comforting.

Measures of energy could hardly be more awkward. I tried to persuade the Committee on Nuclear and Alternative Energy Systems, of which I have been a member, to use the "bulb" — 100 watts — as the basic unit on the grounds that everbody can readily envision it. The bulb describes energy flow, not energy stock, but the bulb-hour will do for the latter. I got nowhere with this suggestion. We still wallow in B.t.u.s (British thermal units) — surely the last relic of George II in this country — and quads (a quadrillion B.t.u.s), which conveys remarkably little to anyone. I cannot remember raising a pound of water one degree Fahrenheit in my life, much less a quadrillion pounds of water.

I shall ignore the absurdities of centigrade. I wouldn't buy a kilogram of anything, but on the other hand the ton is hardly more rational. The stone is useless, aside from its delightful property of equaling 14 lbs. of live meat and 8 lbs. of

dead — which is about the transition ratio.

If I appear frivolous, I do find it hard to discuss measurement without snickering. But surely it is time for the scientific community to say boldly that the metric system is as arbitrary as any other, and in many ways less well adapted to human psychological needs. Its only defense is that it is convenient for us all to tell the same lies. Once we've agreed to be consistent, perhaps we can begin to study what numbers mean most to most people. I recommend the task particularly to the psychologists, who have neglected the psychology of measurement only because — ironically — it is not amenable to exact measurement.

Exact measure is scientific ritual. It comforts the mind, but is not very significant in the real world, where we find no numbers but only shapes, rough proportions, and occasional equalities; things fitting into one another, and things falling apart. □

Cowen

Continued from p. 7

Even many biologists, while remaining skeptical, might join in the fun. But when the two theorists try to explain some of the great epidemics of history as the result of invasions by alien viruses or bacteria, the hackles of experts are bound to rise. When this latest proposal appeared in *New Scientist* for November 17, editor Bernard Dixon anticipated the protests of epidemiologists that established mechanisms could well explain all known epidemics. But because the Hoyle-Wickramasinghe theory "has important practical implications," he said, "we have decided to publish it, in the hope that it is fully appraised and criticized by the scientific community." So far that community seems to have been either too startled or skeptical to respond.

Some years ago, Dr. Hoyle published an intriguing science fiction novel — *The Black Cloud* — in which an interstellar cloud that proves to be an intelligent being visits the solar system. Drs. Hoyle and Wickramasinghe seem well on their way to turning that science fiction theme into a seriously advanced scientific theory. Asked if he thought such a being might exist, Dr. Wickramasinghe replied: "It's an intriguing idea. Why not? If complex chemistry can arise on different bits of dust, why should they not communicate together to form one intelligent being? The difference between ourselves and an amoeba is the superior communication of our nervous system." □

Rollinson

Continued from p. 13

tries — even continents — and we complain of the need to redistribute the "wealth" to the less fortunate as though "wealth" were finite: a sugar bowl. The redistribution syndrome is very powerful. Indeed it appears to have spawned an egalitarian political philosophy that is embraced in one form or another by at least three-fourths of the people of the world!

Popular delusions just aren't much fun to discuss. And they're as difficult to dispel as an angry mob. To shrink away and let the wrath of the mob subside is wise though not courageous. To join the mob is reprehensible. So it is with delusions. □

CITIVIEWS

CITIVIEWS is distributed quarterly to Citicorp investors. It contains viewpoints on timely public issues. We believe the following may be of interest to you...

The Public Interest

"It was a terrible week. First we found our Automobile Club infested with pedestrians...then we discovered six experts who'd infiltrated the Laymen's Association...and Friday we caught three people in the Public Interest Forum secretly pursuing their own special interests...."

No one is known to have actually reported such a week, but it should come as no surprise if someone eventually does. Certainly, it is the sort of thing against which many of the voices raised "in defense of the public interest" seem to be warning us.

Probably no phrase in the English language affords more ambiguity or opportunities for demagoguery than "the public interest." Aside from the obvious question of who has the right to speak "for" the public, there is the still larger problem of just whose interest is being protected, and from whom.

What, exactly, is The Public? Who belongs to it, or, conversely, who does not? If The Public includes everyone, then the individual who volunteers to "defend the public interest" is really offering to protect us from ourselves. If The Public does not include everyone, then who has been excluded, and on what authority?

Or perhaps instead of one great Public we are referring to many smaller ones: as in the traveling public, the investing public, the theater-going public, or the Nielsen public. After all, people do form themselves into groups based on a community of interest, and those interests will sometimes conflict with one another. In that event, perhaps, the public interest advocate fills the role of impartial arbiter, dispensing justice or at least wisdom from some neutral vantage point, free of the special interests that entangle everyone else. But sometimes that neutral territory is hard to locate, and its disinterested inhabitants hard to identify.

Anyone trying to cross a busy intersection on foot, for example, knows that pedestrians and motorists sometimes have conflicting interests. So does the motorist trying to turn the corner. If there is a debate tonight in City Hall about altering the traffic lights for the greater convenience of one group or the other, whose side will you be on? And regardless of what you believe at the moment, how do we know you can be trusted? You might start out as a motorist, find a parking space on the way downtown, and arrive as a pedestrian. Yet, does it follow that we can find a fair solution to the problem only with the help of someone with no commitment to either side; that is to say, somebody who neither drives nor walks?

The purpose of this line of reasoning is not to denigrate anyone's efforts to speak disinterestedly on behalf of the general welfare, but merely to invite attention to certain aspects of the *pro bono publico* dialogue that are too often overlooked.

Consider, for example, the question of consumer advocacy. While there may be some uncertainty about just who or what constitutes a public, there is no doubt whatever that we are all consumers. Since no meeting can be held in which everyone present is not equally a

consumer, who then does the "consumer representative" actually represent? Clearly, it must be either (1) a specific group of people who have in some manner selected a delegate to convey *their* convictions to the meeting; or (2) the speaker's own point of view.

In the latter case, the "consumer advocate" (at a stockholders' meeting, for instance) should really be saying something like this:

"I realize that everyone here is as much a consumer as I am. But you have other interests that may be more important to you than your interests as consumers. Since I am free of such conflicts, or able to deal with them more objectively, I am here to serve as the authoritative spokesman on that subject."

This is not, of course, the way such representations are usually made.

If, on the other hand, the advocate appears as the representative of a formal, organized group, the problem of objectivity becomes even more troublesome. Any organized group of people constitutes a special interest—by definition. Moreover, the longer an organization exists, the more specialized its interests become. It is unnecessary to demonstrate this fact: it is immediately apparent to anyone with even a passing acquaintance with any group, even if only a bridge club. Nor is objectivity—or the lack of it—linked solely to the profit motive, as any philanthropist can testify who has tried to honor competing claims by representatives of equally worthwhile charities.

Over the past decade, there has come into existence something often referred to as "the public interest community." It consists of men and women with a common desire to emphasize certain values and social perspectives—e.g., a clean environment—that affect all of us alike, and to act on behalf of those values whenever and wherever they perceive the rest of us to be neglecting them. It does nothing to detract from anyone's efforts to suggest that even the noblest cause can at length become a vested interest, or that it may attract at least a few who are perhaps more interested in doing well than in doing good.

Every American is entitled by law and the Constitution to fair representation by a president and a vice-president, two senators and a congressman, not to mention a governor, a state legislator, and probably a mayor. The vigor of our two-party system and the frequency with which we return our officials to private life testify that these legal representatives sometimes leave many of us less than satisfied. Anyone stepping forward to supplement their efforts by reminding us that something that ought to be done is not being done, or vice versa, should always be welcome in the national meeting hall.

It is only prudent, however, to review occasionally what used to be called in the Old West their *bona fides*. And it seems only fair to recall, from time to time, Dr. Johnson's admonition that "a common prejudice should not be found in one whose trade it is to rectify error."

Trend of Affairs

ENERGY

New Safety at the Mine-Man Interface

Though coal mining remains one of the most hazardous of U.S. occupations, it is vastly safer than it used to be. Fatalities were down from almost 1,000 a year in the late 1940s to less than 150 a year in the mid-1970s. There were only 29.22 disabling injuries per million man-hours of coal-mining employment in 1974.

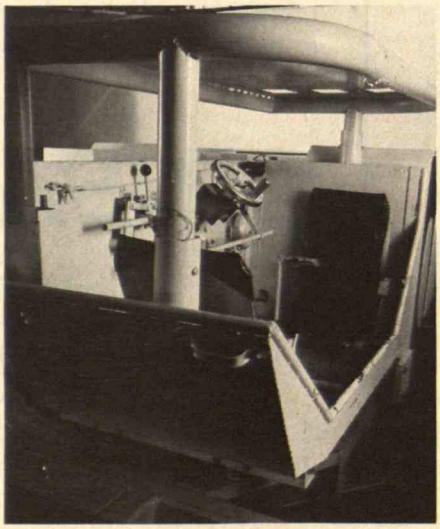
But the downward trend toward greater safety in the mines, which followed enforcement of the strict regulations of the 1969 Coal Mine Health and Safety Act, suddenly flattened and then reversed in 1976, rising to 36.41 per million man-hours. The Act's emphasis on controlling environmental sources of injuries — methane and coal dust explosions, "black damp," and fire, for example — has gone about as far as it can go, three mine-safety experts told the Human Factors Society at its annual meeting in San Francisco last fall.

Now it's time to focus on the miners themselves, according to William J. Wiehagen and James M. Peay of the U.S. Bureau of Mines in Pittsburgh and Reid P. Joyce of Applied Science Associates, Inc., of Valencia, Penn. "Human factors" research can yield another downtrend in mining accidents, they said, urging three new thrusts:

☐ Make mining machines safer for the workers who use them.

☐ Improve the training of miners.

☐ Improve the "work climate" in the industry so that supervisors and managers understand how their work can encourage safe practices.



A device which simulates a shuttle car cockpit will be used to train operators. An operator's familiarity with the simulator should enhance the safe operation of actual shuttle cars in coal mines. (Photo: U.S. Dept. of the Interior)

Mines became safer in the 1950s and 1960s because machines were substituted for men in the most hazardous jobs. But those machines are themselves far more hazardous than they need be, said the three safety experts: indeed, machines are now "a leading contributor to serious injury."

Until efforts of Dr. Joyce's firm beginning in 1974, every mining machine had its own kind and configuration of controls; the switch to stop one was operated by the right hand; another's, by the left foot. Now they're more nearly standardized. But the manufacturers of mining machines still pay too little heed to the comfort and vision of the operator, and more research on the "man-machine interface" is needed.

"The training business is wholly unfamiliar" to many coal companies, said Messrs. Wiehagen, Peay, and Joyce. Tradition holds that miners ". . . learn by doing and take their lumps when they make mistakes. . . . The shuttle-car driver, unable to see the corners of his machine, learned where they were by running into the walls a lot. . . . People were caught in, struck by, or buried beside their machines with alarming regularity, often because they simply didn't know how to use them properly."

The need for training programs was obvious, and efforts at developing such programs and badly needed training devices are now well under way. Cockpit simulators and scale models to familiarize shuttle-car and dragline operators with their vehicles have been devised by the Bureau of Mines, working with Applied Science Associates, Inc., and the design for a continuous-mining-machine trainer is presently on the drawing board.

Applied Science Associates' research shows that disabling injuries decrease when morale is high, management flexible and innovative in adopting new procedures, and production pressure relaxed. So the Bureau of Mines is now creating training programs in employee relations and planning skills for mine management.

With the increased emphasis on coal, programs to enhance the safety of mining, long overdue, are welcome indeed. Now time will tell if three prominent causes of accidents — poorly designed equipment, inadequate training, and poor supervision of workers — can be eliminated with results as spectacular as those which derived from the attack on environmental injuries. — *J.M.* ☐

Good News: O.P.E.C. Is in Bed With Us

You're worried about all those Arabian sheiks investing their new-found O.P.E.C. wealth in U.S. stocks, bonds, and real estate? Don't.

To Professor Donald R. Lessard of M.I.T.'s Sloan School of Management, such investments are good news. The need to worry would come if the O.P.E.C. countries were spending all their wealth instead of investing some of it.

Here's how his reasoning goes:

Put yourself in the place of the Saudi Arabian who owns a rich, producing oil field. You could easily — and unintentionally — cause mischief in the world's financial markets by concentrating your new wealth in any one of them, where your resources and influence could overshadow everyone else's. Or you could accidentally upset any national economy by taking control of a principal industry whose technology you didn't understand.

On the other hand, if you wanted to avoid causing mischief and assure for yourself a balance between present and future income, you would behave very much as the O.P.E.C. nations are behaving today — making conservative, diversified investments, most of them long-term, while maintaining a low profile in the markets.

Since the first convulsions following the boycott of 1970, the O.P.E.C. nations have settled into a fairly predictable buying pattern, says Professor Lessard: they're trying to assure their future income by purchasing claims against future profits in the industrial nations — stocks, bonds, and real estate — to the tune of $35 to $40 billion a year while spending the balance — up to $115 billion in 1977 — for goods and services.

Far from being a threat, O.P.E.C.'s western investments are security for us as well as for them. By taking some of their money in long-term financial claims against "our" world instead of simply buying today's goods at today's prices, the O.P.E.C. countries "have locked themselves into a stake in the stability of future world markets," says Professor Lessard. To the extent that they invest in any one nation's future production, they have a stake in that country's productivity and in the stability of its currency.

It's what Professor Lessard calls the "bedfellow theory": if you're worried about what your neighbors may do to you, make sure that anything that hurts you will also hurt them. — *J.M.* □

Jon McIntosh

Energy: Turning Uncertainty to Gain

What we loosely call the energy crisis began almost a decade ago, when for perhaps the first time the cost of finding and producing a unit of energy from new sources became greater than the average cost of producing a unit of energy from existing sources. In the jargon of economics, this cost difference is the "marginal cost" of new energy.

This new relationship represents a fundamental and radical change in energy economics: each unit of energy we use in the future will cost more than the like unit previously consumed. The situation bears special peril for the U.S., whose industrial strength has been built on abundant, cheap energy, but it also offers unique opportunities for those in American industry who are perceptive and aggressive enough to seize them.

Speakers at a symposium on energy management sponsored by the M.I.T. Alumni Center of New York in December made these pertinent observations:

□ Many nations have developed industrial enterprises competitive with those of the U.S., while consuming far less energy. Germany and Japan, for example, obtain 40 per cent more output per unit of energy than the U.S., says George N. Hatsopoulos of Thermo Electron Corp. As a result, rising energy prices work to put our products at a special disadvantage on world markets just at a time when the U.S. needs to sell more goods overseas to pay for more imported fuel.

□ The price of U.S. energy has been kept artificially low and must rise to a more equitable level if the traditional forces of the marketplace are to be strong enough to stimulate energy conservation.

□ The era of cheap and abundant mineral resources is ending. The threat of more expensive, poorer ores is compounded by the certainty of higher energy prices — the poorer the ore is, the more energy is needed to refine it.

□ The cost of imported oil has had a "devastating impact" on U.S. balance of payments and the international value of the dollar, according to John S. Chalsty,

Director of Research at Donaldson, Lufkin, and Jenrette Securities Corp. He forecasts "volatile and uncertain international policies" for U.S. firms in foreign markets and reduced incentives for foreign investment in U.S. companies.

☐ We will not literally "run out" of oil; it is not realistic to worry about the "last" shipload of crude or the "final" producing well. But as the richest Middle East oil fields become depleted, pushing up the marginal cost of oil, we can look forward to new tension and even crisis in the 1980s.

Confronted by these gloomy conditions, how should the U.S. respond? Five symposium participants offered these specific recommendations:

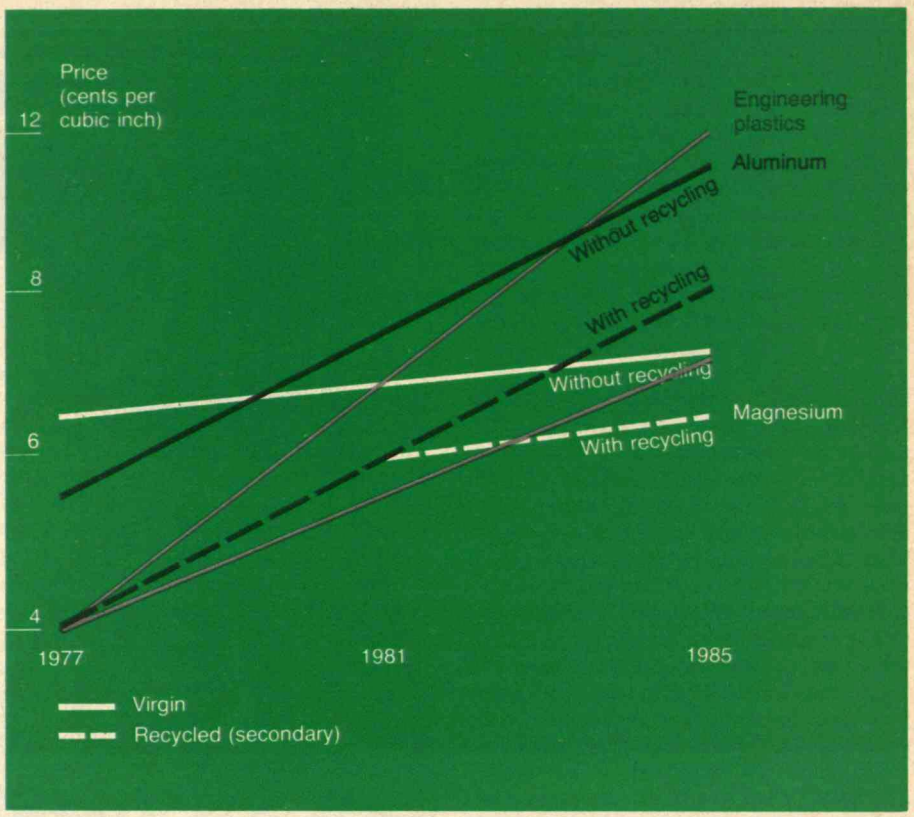
J. Herbert Hollomon, Director of the Center for Policy Alternatives at M.I.T., cautions against wasting money on a massive, short-term research and development effort to cut the cost of energy and urges research aimed at increasing our industrial productivity. Our need is to compete in world markets so that we can buy the energy we need from the Middle East, he points out; by emphasizing productivity in the past we achieved leadership in the world markets of agriculture, military arms, and computers.

John J. Donovan, Associate Professor of Management Science at M.I.T., underscores the need for logical analysis of existing energy information. He and his associates in the Management Information Systems Group have developed methods to draw on vast but uncoordinated bodies of data on energy resources and consumption that exist throughout the U.S. He's convinced that these new techniques represent at once an important new business opportunity in the data processing field and a vital resource for energy analysts, planners, and policymakers.

Dr. Hatsopoulos recommends aggressive innovation to use energy more efficiently. The thermodynamic efficiency of U.S. energy consumption now ranges between 33 per cent (electrical generation) and 8 per cent (household consumption), averaging only 13 per cent. In comparison, Japan's average is 17 per cent, and he says our need to "restructure American industry to achieve optimum energy efficiency is great enough to be called a crisis." Companies that respond to this challenge promptly and aggressively will find themselves with a "tremendous competitive advantage" in the future.

James M. Utterback of the Center for Policy Alternatives is optimistic. Adversity is the principal source of innovation, he says, and change is a breeder of change. When incandescent electric light bulbs threatened the market for illuminating gas, the gas industry responded by inventing the gas mantle. The threat of aluminum automobile engines led to development of thin-wall iron engine castings, which now dominate the industry. Similarly, the demand for processes and equipment to reduce energy consumption will be a powerful innovative force.

Jerome B. Wiesner, President of M.I.T., calls for flexibility and tolerance for uncertainty. Our difficulty in coming to grips with the energy problem is a symptom of our larger problem: the inability to understand complex systems of all kinds, he says. Countless social and technological uncertainties confront us — the feasibility of fusion reactors, the health effects of fossil fuel combustion, the environmental dangers of offshore oil. Weighing all these in a single, comprehensive policy asks too much, Dr. Wiesner stated. Indeed, it represents a goal of eliminating uncertainty and risk, which seems to him a "serious threat to our society" because it "discourages innovation at just the moment when innovation is most needed." Instead, he said, our purpose should be to "give business courage to live in a world of energy uncertainty." — *J.M.* ☐



In 1977 magnesium cost six cents per cubic inch (about $1 per pound), substantially more than aluminum. By 1985 it may be the other way around. Although the effect of recycling on magnesium costs is shown here, demand for the metal may be so strong by 1981 that recyclable magnesium will be unavailable. The cost projections of engineering plastics reflect two different estimates for ethylene prices — annual increases of 7 and 13 per cent — between 1977 and 1985. (Chart: Richard B. Stein, "Trends in the Price of Magnesium in Comparison with Competitive Materials")

MATERIALS

The Coming of the Age of Magnesium

In a time when people wonder about running out of copper, chromium, and even aluminum, magnesium has a certain appeal: almost limitlessly available in sea water, it is the third most abundant structural element in the earth's crust.

Magnesium is 50 per cent lighter than aluminum, so it has great appeal in applications where weight swings a heavy hand. Indeed, on balance, participants in an international conference on magnesium held last year at M.I.T. made clear their confidence that magnesium's "time has come" as a structural metal. The other side of the coin is that magnesium is today more expensive per pound *and* per unit volume than aluminum, its nearest competitor. Producing a pound of magnesium requires up to 170,000 B.t.u. of energy compared to 120,000 B.t.u. for aluminum, which is itself a highly energy-intensive material.

At nearly $1 per pound, magnesium now costs almost twice as much as aluminum. But by 1985, says Richard B.

Stein of Bechtel Corp., the two may not be far apart, at about $1.10 per pound. The price of aluminum will rise so fast because world supplies of bauxite, the principal ore, are controlled almost entirely by a few nations in the developing world. Mr. Stein projects that by 1980 alumina, the partially refined form of bauxite, will represent nearly half the cost of aluminum, in contrast to 25 per cent today. In contrast, no such monopoly threatens the magnesium industry, which stands to benefit from some infusions of new smelting and refining technology.

The low density of magnesium gives it special leverage in transportation equipment — the weight reduction yields immediate advantage to the maker and long-term advantage to the user. The metal is not unknown, therefore, to automobile designers. Every 1,500-cubic-centimeter engine in a Volkswagen "Beetle" has a magnesium crankcase, and every "Beetle" has a magnesium transmission case. Many oil pump components and fans in Mercedes and B.M.W. cars are likewise of magnesium.

And now there's a new incentive: the necessity faced by U.S. automakers to meet statutory fuel economy goals. Trimming about 200 pounds of weight from a vehicle will improve its fuel economy by about one mile per gallon. Ford has found, for example, that magnesium intake manifolds for a mid-size V-8 engine weigh 43 pounds less than similar manifolds made of iron. In addition, Ford is studying the use of magnesium instead of aluminum for a number of castings — steering column parts, master brake cylinders, and distributor housings, for example. But a switchover to magnesium hasn't happened yet, and won't occur, says Maxwell S. Holland of Ford Motor Co., until the cost ratio per pound between magnesium and aluminum is 1.3:1. That compares with today's 2.0:1 and with a 1:1 ratio predicted by Mr. Stein for 1985.

If Mr. Stein is right, look for a big bulge in the magnesium market — and for some hefty energy savings. George B. Kenney and Professor Joel B. Clark of the M.I.T. Department of Materials Science and Engineering are convinced that "substantial net energy returns" could be obtained by substituting magnesium for iron castings in automobiles, considering the energy requirements of smelting, manufacturing, and driving. They calculate that each pound of magnesium substituted for similar steel parts would save 6.89 gallons of fuel per 100,000 miles of driving. — *J.M.* □

Automobile parts made of graphite-epoxy composite weigh far less than similar parts made of steel. However, composite-parts are weakened by exposure to weathering typically experienced by automobiles. Epoxies oxidize upon prolonged exposure to the ultraviolet light in sunlight; graphite fibers fray when rubbed or eroded by road debris; and exposed fibers readily absorb water, weakening the composite even further. (Data: Ford Motor Co.)

	Steel (lbs.)	Graphite (lbs.)	Reduction (lbs.)
Hood	40.0	15.0	25.0
Door, right rear	30.25	12.65	17.60
Hinge, upper left front	2.25	.47	1.78
Hinge, lower left front	2.67	.77	1.90
Door guard beam	3.85	2.40	1.45
Suspension arm, front upper	3.85	1.68	2.17
Suspension arm, front lower	2.90	1.27	1.63
Transmission support	2.35	.55	1.80
Driveshaft	17.40	12.00	5.40
Air conditioning, lateral brace	9.50	3.25	6.25
Air conditioning, compressor bracket	5.63	1.35	4.28

Composites: Strong, Light, and a Heavy Price Tag

A structural material lighter than aluminum, tougher and stronger than steel, tailored to exactly withstand predicted stresses . . . an engineer's dream, turned almost into reality by advanced composites.

These hybrid materials consist of two fractions: strong, fine (0.0003 to 0.005 inches diameter) fibers, embedded in a matrix, such as epoxy which is "cured" for several hours at temperatures of up to 350°F and pressures of up to 100 pounds per square inch. When layers of fibers — boron and graphite are two favorites — are laid out at carefully controlled angles, a finished composite can be made to withstand precisely the tensile, compressional, shear, and torsional stresses to which it will be ultimately subjected.

Because the strengths and stiffnesses are aligned in the required directions, such custom tailoring can achieve great weight savings. But the cost of advanced composites in their present hand-assembled form is high — $40 to $200 per pound, compared with aluminum and titanium alloys from about $2 to $15 per pound. Their use in aerospace applications is generally cost-effective, especially, for example, in the Space Shuttle. They are also used where consumer resistance to cost is easily overcome — in the handles of expensive golf clubs, frames of racing bicycles, cords of premium tires, and in an occasional Presidential bullet-proof vest.

The Shuttle's aft-thrust structure, made of titanium beams wrapped in boron-epoxy composite, weighs 900 pounds less than if made of metal alloy; the graphite-epoxy payload bay doors weigh 1,070 pounds less than would aluminum doors; the mid-fuselage frame, made of beryllium-aluminum composite tubes, are 180 pounds lighter than a similar section of alloy tubes would be.

Encouraged by these weight savings, the National Aeronautics and Space Administration has embarked on a five-year composite development program, which will move advanced composites, now used for the empennage surfaces on military aircraft, closer to widespread use in commercial aircraft. Before new materials can be routinely used in airframes, they must win approval of the Federal Aviation Agency. Until this approval is granted, users of composites in commercial aircraft face, "a product liability problem, which makes it difficult to gain service experience," according to James W. Mar, Professor of M.I.T.'s Department of Aeronautics and Astronautics. Professor Mar estimates that one-third of the total cost of putting advanced composites into aircraft may be incurred by the tests necessary to win F.A.A. certification.

Materials used in automobiles don't need such rigorous certification, and their current quest for fuel economy through weight savings is leading U.S. automakers

to consider the advantages of advanced composites. Engineers at Ford Motor Co. calculate that the weight of a Granada-size car — 3,725 pounds — could be reduced to only 1,753 pounds by using 225 pounds of composite materials. This dramatic reduction would lead to a smaller engine (110 cubic inches displacement, down from today's 250 cubic inches) and far greater economy — from the current 18.6 to 31 miles per gallon of gasoline, according to Ford.

But don't look for composite cars in auto showrooms yet. The high cost of composites is not the only real barrier to their use in consumer products. The behavior of epoxies under long-term stress and exposure to the environment must be tested — some composites absorb moisture; others are degraded by sunlight; there is no easy way to join composite parts without bolting them through weakening drill holes; and repairing broken composite parts in the field requires ingenuity and invention.

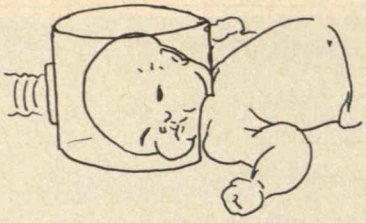
The basic difficulty, says Professor Mar, is that unlike metals, plastics, and glass, composites are not homogeneous or isotropic; that is, their composition and properties are not uniform throughout. Today's designers and engineers are "inhibited," he stated, because they are experienced with only homogeneous, isotropic materials. This lack of experience presents a whole new range of problems with which engineers and designers must deal. He added, "The Department of Aeronautics and Astronautics [at M.I.T.] has graduated a couple of generations of students who understand composite materials better than metals, and it will be young people who will fully exploit the advanced composites." — *L.A.P.* □

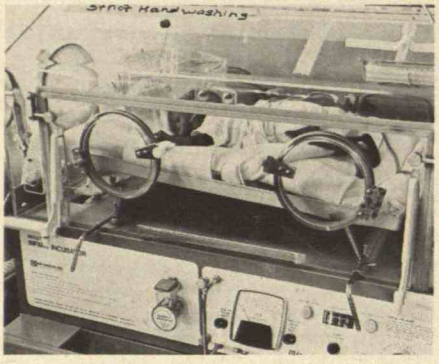
CHILDREN

Babies: Forgotten by Bioengineering?

Incubators keep infants warm, oxygen caps keep them alive, and hospital lighting keeps them in view of nurses. But the medical technologists who design such devices think far too narrowly of an infant's psychological needs, says Coryl LaRue Jones of the National Institute of Mental Health.

Picture a baby in an oxygen tent. It is subjected to 70 or 80 decibels of sound pressure; there is an impenetrable barrier between its eyes, ears, nose, and mouth and its hands and body and the outside world. It is at the apex of an acoustical reflector; its own sounds, superimposed on the background noise, are distorted like the sounds in a vaulted cathedral. Seen through the clear plastic, the nurse may seem to have two noses and four eyes; reflected from the plastic the baby may perceive itself to have four hands.





Premature infants in plastic oxygen hoods *(above)* perceive an outer world that is obscured visually by distortion, reflection, glare, and condensation (especially when they're crying). Sound levels inside the hood can range from 85 to 105 decibels. Reflections and distortions in the curved plastic surfaces of an incubator *(below)* further degrade vision. The head of the baby in the incubator has started to slip out of the neck hole of the hood, and the hood rim is cutting into the baby's mouth. (Drawing: Coryl LaRue Jones; Photo: National Institute of Mental Health)

Recognizing this, medical technologists have now devised a partial substitute for the incubator — a "baby warmer" which amounts to a small bed with a radiant electric heater above. Its sides are normally of patternless stainless steel, reflecting the constant (day and night) overhead lighting. Ms. Jones calls it a "bun-warmer," hardly an improvement at all.

These are typical examples of modern medicine's failure to consider its youngest patients as humans, she told the Human Factors Society's 1977 annual meeting in San Francisco.

"Physical settings specifically designed to enhance the overall social, emotional, cognitive, and physical development of infants are almost nonexistent," she said. "Specialized settings, in fact, tend to be the greatest violators of comprehensive concern for the infant's environment because they target specific needs to the detriment of other equally important developmental needs."

Why so much concern for infant environments? Because, says Ms. Jones, during the first two years of life "the brain develops faster than it ever will again." Environmental experience during this period is essential to the formation of the brain and its interconnecting links and to development of blood flow. "Environmental stimulation and human development are inextricably linked in the first months of life," she told the Society.

Accordingly, she wants infants to have environments which assure cyclical variations of light and temperature, moving visual foci, and sound stimuli, plus opportunities for social relations, games, and intimacy. "We can create retardation, developmental delays, and abnormal behavior by depriving infants of these essential experiences," she said.

It's a whole new dimension of concern for medical technology, on which it now earns poor marks. — *J.M.* □

Children At Risk

Reports of abused children are pouring into registries and agencies at a staggering rate, and some projections are reaching one million cases a year, says Elizabeth Elmer, Director of Research and Development at the Parental Stress Center in Pittsburgh, Penn. She suggests that, "we may be confronted, not with a pathological or unique occurrence, but with a cultural deviation built into our society."

She blames common fallacies and widely accepted practices of child rearing, finding evidence that some parents feel almost duty-bound to slap, beat, or otherwise attack their children. In an investigation of infant abuse using a sample ranging from very low to very high socioeconomic class, Ms. Elmer found that 80 per cent of the mothers were using physical punishment by the time the children were 12 months old. Few of the mothers distinguished between teaching and punishment. This confusion is mirrored by the continuing support for corporal punishment in schools by some educators. For example, only last December the National Advisory Committee on Child Abuse and Neglect reached a majority decision to recommend the ending of corporal punishment in schools, and even then committee members were sharply divided on the issue.

Ms. Elmer discovered that abusive mothers and fathers often expect a higher level of competence than the child is capable of, or perceive that he is purposefully antagonistic or malicious and stubborn. These unrealistic expectations are a potent source of stress which increase the chance of violent outbursts.

Brandt F. Steele, Professor of Psychiatry at the University of Colorado Medical Center, notes another factor contributing

on the child for reassurance and nurture instead of allowing the child to rely on them. Such parents were likely abused themselves as children: it is no surprise that they lack resources (empathy, compassion, controlled emotions) for healthy parenting. Through the processes of identification, child abuse is perpetuated.

Effects are more than physical. Abused children suffer from low self-esteem because they have been criticized, belittled and punished. They share such characteristics as apathy, depression, and a lack of spontaneity and joy. Even in non-head-injured children, Dr. Steele finds that low I.Q.s, language deficits, and special learning problems are common. Dr. Steele discovered that among 100 juvenile first offenders he studied, 84 had been physically abused before school age, and 92 had been bruised, lacerated, or fractured by a parent within a year and a half prior to pick-up. Early child abuse appears often to precede more violent and hardened criminal behavior, as well.

Since child abuse poses serious problems for society in addition to the personal tragedy, what solutions are proposed? Richard J. Gelles of the University of Rhode Island advocates more reliable studies of incidence, modes, and patterns of abuse. Statistics at present are spotty and incomplete because many cases go unreported. It is important that all possible sources — schools, hospitals, physicians — be aware of their responsibility to report cases. Once located, children at risk and their families can be aided by social agencies.

Investigators are developing methods to identify high-risk parents and their infants at the time of delivery, reports Elizabeth Elmer; early identification and advice from pediatricians and clinicians is one step toward prevention. In addition, Ms. Elmer proposes mass-media campaigns to educate parents about children's capabilities at various age levels.

Jack Hagenbuch, Coordinator of Protective Services for the Massachusetts Department of Public Welfare, says that in addition to sufficient investigative and family counseling services, self-help organizations such as Parents Anonymous are achieving success. Here, parents can discuss their impulses to strike out, and become aware of the mechanisms which trigger their reactions. And even more important, according to Mr. Hagenbuch, the parents receive support and understanding which they in turn can more easily give to their children. — *Sandra Knight* □

"Diablo Hand" and a Solar Hot Line

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Activities in the Mathematics Department at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

One of our readers who shall remain nameless has actually expressed an interest in compiling an anthology of selected problems from Puzzle Corner. Considering the author I expect that the book will be quite good; but I wonder to whom we should give the movie rights. Any suggestions on problems to include/omit will be forwarded to the author.

I am always amazed by the geographical dispersion of my readers. Receiving a letter from Tony Osmond, Science Editor of *The Sunday Times Magazine,* was certainly a pleasure. Contrary to the beliefs of many New Yorkers, *The Times* is published in merry old London.

R. Robinson Rowe suggests another way of looking at my comment that York College freshmen look younger each year: "Ipso facto, as a corollary," he writes, "you look more mature and professional to the incoming freshmen. More at Harvard than at M.I.T., I noted and remember how the recruits to academe, as teaching fellows, instructors, and even assistant professors, feigned maturity with dignified reserve, pretense of sophistication, and sprouting hirsuteness (a van dyke or mutton-chops). But the old masters, the full professors and occupants of Gordon McKay chairs (as a rule but with exceptions), were clean-shaven, gregarious, sociable companions of students — in classroom and stadium. There was a legend of Charley and Ed en route via horse and buggy to the Harvard-Yale football game. Charlie was President Charles W. Eliot; Ed was Edward Everett Hale. As they drove slowly through Harvard Square, a friend asked, 'Where ya going, Charley?', which was answered by 'To yell with Hale!' "

One item of business: chess problems are in very short supply.

Problems

M/A 1 We begin with a bridge problem from Albert J. Fischer — a hand which he says is entitled the "Diablo Hand" in Albert Ostrow's long-out-of-print *The Bridge Player's Bedside Companion.* Having set it down from memory, Mr. Fischer warns that the "spot cards may not be exact, but the ones that matter are properly placed."

Given the following hands, and the bid of seven spades by South:

	♠ — ♥ A 10 8 6 ♦ A K Q J ♣ A J 10 7 5	
♠ 9 2 ♥ Q 9 7 ♦ 7 6 4 3 2 ♣ K Q 6		♠ 7 6 5 4 3 ♥ K 5 4 3 2 ♦ — ♣ 9 4 3
	♠ A K Q J 10 8 ♥ J ♦ 10 9 8 5 ♣ 8 2	

After the opening lead of the ♥Q, South has 12 tricks. Where will the 13th come from?

M/A 2 Theodore Engle believes that he knows the smallest positive integer containing at least 1 million distinct proper factors. What is this factor champion? (The factors need not be prime; for example, 12 has four factors — 2, 3, 4, and 6.)

M/A 3 Neil Hopkins has an easy way to remember Tim Lefever's phone number: H. R. ("Tim") Lefever, farmer, environmentalist, and electrical engineer (M.I.T. '41), has an unforgettable phone number, whose digits can be represented as (abc) efg-wxyz. If anyone needs to telephone Lefever to inquire about his solar-heated house, built in 1954, one needs only to remember the following:

☐ The area-code (abc) is a palindrome the sum of whose digits is the square root of the exchange number (efg).

☐ The exchange number (efg) is the square of the sum of the last three digits of the phone number (wxyz).

☐ The last three digits of the phone number (xyz) are consecutive numbers, increasing order, and the sum of the cube of the first three equals the cube of the last. ("I hope I have been helpful," writes Mr. Hopkins.)

M/A 4 Frederick Kummer has submitted the following:

My favorite solitaire card game (called accordion, among other names) consists of dealing a deck, one card at a time, and then examining sets of four cards. If the four cards are of the same suit, the middle two are discarded. If the four cards are of the same value, all four are discarded. What are the odds of winning (no cards left)? What if the whole deck is laid out before starting?

(Mr. Kummer notes that he is not aware of a solution, and he wonders if one is obtainable "without serious number-crunching.")

M/A 5 Stephen Hirshman has a trigonometry problem for us:

It is well known that the trigonometric functions of certain spiral angles are algebraic numbers. For example, $\sin 45° = \sqrt{2}/2$, $\sin 15° = \frac{1}{4}(\sqrt{6} - \sqrt{2})$. What is the smallest integer angle A for which such an explicit closed-form expression for sin A may be obtained?

Speed Department

M/A SD 1 James Cawse and Peter Stonestrom offer us a problem that was proposed and solved by a group of mountaineering mathematicians at the top of the talus pile below Tapeats Cave, Grand Canyon: Do the number of possible routes down a talus pile form a countable or uncountable infinity?

M/A SD 2 We close with a problem from John E. Prussing:

Consider a one-dimensional pursuit-evasion problem in which, at the initial time, the evader is a distance x ahead of the pursuer. The pursuer and evader travel at constant speeds p and e, respectively. In terms of $\alpha = e/p$, derive a simple expression for x^*, the position at capture (assuming the pursuer starts at the origin) in terms of x_0 and α, and a simple expression for the time of capture t^* in terms of t_0 and α (where t_0 is the time required for the pursuer to reach the initial location of the evader). What is the condition on α for capture?

Solutions

DEC 1 White to play and mate in two; see chessboard on facing page:

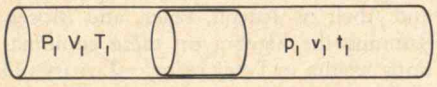
As I anticipated, this problem caused little trouble. Michael Delaney polished it off as follows:

White must begin with B — B2. The continuing variations are:

Black:	*White:*
N–Q2 or N–B3	B–N6 mate
N–B5 or N–B6 or N–N5	B–N6 or B–R4 mate
N–Q6 or N–B2	B–R4 mate
N–N3	B × N mate.

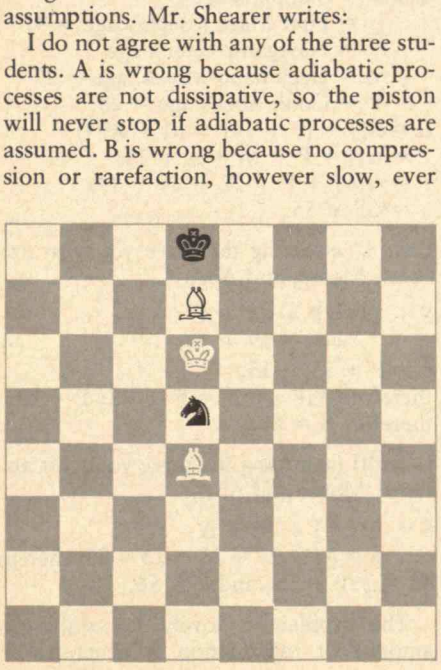
Also solved by E. Leroy, Robert Lack, Jeffrey Wint, Avi Ornstein, J. Fuss, Winthrop Leeds, Lindsay Faunt, Raymond Kinsley, Jacob Bergmann, William Butler, Jr., R. Robinson Rowe, Frederick Bercher, Ken Haruta, Rudy Evans, Scott Byron, Alan Peaceman, Roger Milkman, Gerald Blum, James Shearer, Harry Zaremba, Edward Lynch, Abraham Schwartz, and the proposer, Glen Ferri.

DEC 2 The ends of a closed cylinder, fitted with a leakproof, frictionless piston, are filled with perfect gases having the initial pressures, volumes, and temperatures indicated. If all of the walls are perfect heat insulators, where will the piston finally stop? Three students propose three answers: A says it will stop where P = p, using adiabatic processes. B says the piston will oscillate perpetually. C says: even though heat does not flow *through* the piston, the piston itself will act like a big molecule, and (after many oscillations) the pressures *and temperatures* will equalize. Who is right? Other possibilities?



In marked contrast to the previous problem, no two correspondents agreed! I have selected two views for inclusion and await the slings and arrows I fear will result. Actually, it seems to me that James Shearer and Winslow Hartford are not in disagreement but rather make different assumptions. Mr. Shearer writes:

I do not agree with any of the three students. A is wrong because adiabatic processes are not dissipative, so the piston will never stop if adiabatic processes are assumed. B is wrong because no compression or rarefaction, however slow, ever becomes *exactly* adiabatic; there is always some dissipation, so eventually the piston will stop. C is wrong about the temperature because the definition of equal temperatures implies either thermal contact, which the piston does not supply, or thermal contact with a third body. I say that the piston will eventually stop due to dissipative processes in the two gases (wave motions, or even shocks at high enough velocities). The two pressures will then be equal, but not the two temperatures.



Mr. Hartford writes:

The piston is not adequately defined. If it's *weightless,* as is usual in problems of this type, then energy cannot be stored, and assuming $P_1 > p_1$ will expand adiabatically, while the gas at p_2 will be compressed until $P_e = p_e$; the process will be instantaneous, and $T_e \neq t_e$, in general.

If the piston has *mass,* then the loss in energy will take place as a finite process, and the piston will move into the space of the gas originally at p_1 until $p_2 > P_2$; it will then oscillate back and forth with diminishing amplitude until $P_e = p_e$; the process remains adiabatic and the magnitude and period of the oscillations will depend on the mass of the piston.

If the piston is *not* an insulator, then heat will flow between the two chambers until $T_e = t_e$, and the pattern observed will depend on the thermal conductivity factor of the piston. However, the two final equilibria will depend on the insulating nature of the piston. Solutions follow:
Piston insulating:

Chamber A (left): P_1, V_1, T_1; moles of gases $N = P_1V_1/RT_1$.

Chamber B (right): p_1, v_1, t_1; moles of gases $n = p_1v_1/Rt_1$.

Equilibrium: $P = P_e = p_e$; in chamber A: $N^{RT}e/V_e$; in chamber B: $n^{Rt}e/v_e$.

Since $V_1 + v_1 = V_e + v_e$, it is possible to solve for T_e and t_e, if we bear in mind that $N(T_1 - T_e) = n(t_e - t_1)$ and also know the heat capacity ratios of the ideal gases; for adiabatic expansion $P_1V_1^K = P_2V_2^K$, where K = ratio of C_p to C_v; for an ideal monatomic gas, K = 5/3. To give an example, let P_1,V_1,T_1 = 2 atm., 2 liters, 400° K., and p_1,v_1,t_1 = 1 atm., 1 liter, 300° K. The equilibrium conditions are:

P_e = 1.6667 atm. p_e = 1.6667 atm.
T_e = 375.97° K t_e = 372.10° K
V_e = 2.2558 liters, v_e = 0.7442 liters.

If the piston is *thermally conducting,* then both P_e and p_e, and T_e and t_e are equal and the problem is readily solved by determining the volume occupied by the total gas, and the T as simple mixing of the moles of gas. Assume the same starting conditions; now

P = 1.6667 atm., as before
T = 375° K
V_e = 2.250 liters, v_e = 0.750 liters.

If the piston has mass, then a plot of V, v and T, t, and P, p versus time and a complex calculus operation are needed.

Also solved by: R. Robinson Rowe, William Butler, Jr., Gerald Blum, Harry Zaremba, and Edward Lynch.

DEC 3 Replace each letter by a unique digit to obtain a valid addition:

```
  F I V E
    T W O
+   O N E
-------
E I G H T
```

I have pooled the responses from Theodore R. Goodman and Avi Ornstein:

1. E must be 1.
2. F is either 8 or 9, since the greatest sum of three different digits is 24 and F plus the carried number must total at least 10.
3. I is either 0 or 1, since the sum of F and the carried number comes to 10 or 11.
4. Since E = 1, I = 0.
5. Since I = 0, the greatest sum in the hundreds column is less than 20; so F = 9.
6. Based on the ones column, T is 2 greater than O.
7. Since O + T produces G and carries over one number in the hundreds column, O is 5 or 6 and T is 7 or 8.
8. G is 2 or 4 if nothing is carried from the tens column, 3 or 5 if 1 is carried from the tens column, and 4 (since O and G can't both be 6) if 2 is carried from the tens column.
9. In both the first and third cases, the remaining digits for V, W, N, and H include an odd number of odd digits, which cannot fit into the addition.
10. Only eight possible combinations exist. It is easy to find that only one works: 2 + 4 + 7 = 13.
11. Thus O = 6, T = 8, G = 5, H = 3, and V, W, and N are 2, 4, and 7, respectively. For the last three letters, any of the six possible permutations will work. This means that there are actually six distinct solutions, namely:

9021	9021	9041
846	876	826
671	641	671
10538	10538	10538
9041	9071	9071
876	826	846
621	641	621
10538	10538	10538

Also solved by E. Leroy, Robert Lack, Lindsay Faunt, Mary Shooshan, Charles Mahlmann, James Cooney, Theodore Goodman, Ronald Newman, Raymond Kinsley, Mike Bercher, Scott Byron, Karen Larsen, Jules Sandock, R. Robinson Rowe, William Butler, Jr., Robin Smith, Alan Schwartz, Doug Patz, Sol Hekier, Bob Lutton, Jacob Bergmann, Jon Warren, Doug Szper, Alan Peaceman, Gerald Blum, Harry Zaremba, James Shearer, Edward Lynch, Winslow Hartford, M. Dow, Harry Zantopulas, Winthrop Leeds, and Abraham Schwartz.

DEC 4 It is well known and easily proved that the differences between consecutive perfect squares are always odd numbers and that the difference between two consecutive differences will always be 2, which equals 2!. It is also true that the differences of the differences of the differences of consecutive perfect cubes is always 6 = 3!. In fact, this pattern holds for all natural numbers and zero; i.e., (the differences of)^n consecutive perfect nth powers is n!. Below are several arrays which attempt to demonstrate this more clearly. The bottom line consists of consecutive integers all raised to the same power. Each higher line consists of numbers each the difference of the two numbers beneath it. Note that after making the same number of subtractions as the power in the bottom row, we obtain a row all of whose elements are the factorial of that power. Prove that this is so.

	2	2	2	2	2	2! = 2
1	3	5	7	9	11	
0	1	4	9	16	25	36

	6	6	6	6	3! = 6
6	12	18	24	30	
1	7	19	37	61	91
0	1	8	27	64	125	215

	24	24	24		4! = 24
36	60	84	108		
14	50	110	194	302	
1	15	65	175	369	671
0	1	16	81	256	625	1296

The following is from Doug Szper:

In standard functional notation, this problem can be stated as:

To prove: $\Delta^n x^n = n!$, where

$\Delta f(x) = f(x + 1) - f(x)$, and

$\Delta^n f = \Delta(\Delta^{n-1} f)$.

Proof (by induction) that $\Delta^n x^n = n!$ and

$$\Delta^n \left(\sum_0^{n-1} c_i x^i \right) = 0:$$

For n = 1:

$$\Delta^1 x^1 = \Delta x = (x + 1) - x = 1 = 1!$$

and

$$\Delta^1 (c_0 x^0) = c_0 - c_0 = 0.$$

Assume true for n = k, i.e. $\Delta^k x^k = k!$ and

$$\Delta^k \left(\sum_0^{k-1} c_i x^i \right) = 0.$$

Then $\Delta^{k+1} x^{k+1} = \Delta^k (\Delta x^{k+1})$

$$= \Delta^k [(x + 1)^{k+1} - x^{k+1}]$$

$$= \Delta^k \left[(k+1)x^k + \sum_0^{k-1} c_i x^i \right]$$

$$= (k+1)\, \Delta^k x^k + 0$$

$$= (k+1) - k!$$

$$= (k+1)!.$$

Also, $\Delta^{k+1} \left(\sum_0^{k} c_i x^i \right)$

$$= \Delta[\Delta^k (c_k x^k)] + \Delta \left(\Delta^k \sum_0^{k-1} c_i x^i \right)$$

$$= \Delta(k!) + \Delta(0)$$

$$= 0.$$

Thus for all n, $\Delta^n x^n = n!$.

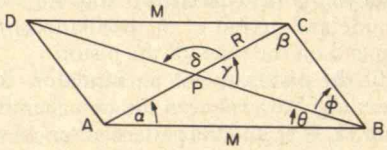
Several respondents noted a connection with higher-order derivatives.

Also solved by Raymond Kinsley, Edward Barton, William Butler, Jr., R. Robinson Rowe, Judith Longyear, Roger Milkman, Gerald Blum, Harry Zaremba, and the proposer, Peter Hadley.

DEC 5 Given two sides, construct a parallelogram whose angles are equal to the angles between its diagonals.

A solution from Raymond Kinsley:

Examination of the parallelogram in question reveals the following:



If $\gamma = \alpha + \beta$, $\delta = \theta + \phi$.

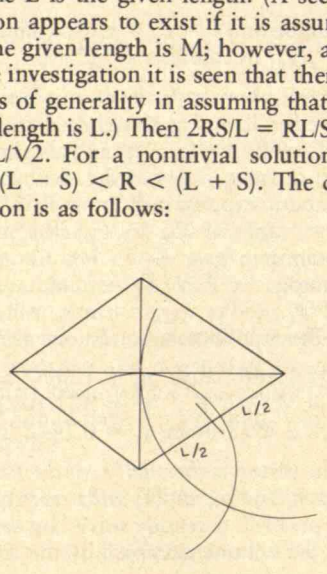
Then, by similar triangles,

Since Δ PCB $\simeq$ ΔCPB with common angle ϕ, then R/S = M/L. Since $\gamma + \phi + \beta = 180°$ and $\gamma + \delta = 180°$, then $\phi + \beta = \delta$. But $\delta = \theta + \phi$; then $\beta = \theta$.

Then, by similar triangles,

Since $\Delta ACB \simeq \Delta ABP$ with common angle α, then 2R/L = M/S.

Assume L is the given length. (A second solution appears to exist if it is assumed that the given length is M; however, after a little investigation it is seen that there is no loss of generality in assuming that the given length is L.) Then 2RS/L = RL/S, or $S = L/\sqrt{2}$. For a nontrivial solution to exist, (L − S) < R < (L + S). The construction is as follows:



1. Construct the perpendicular bisector of L.
2. Mark off a distance of L/2 on the perpendicular bisector.
3. Using one end of L as the center, construct an arc with a radius that will pass through the mark made above.
4. Using the other end of L as the center, construct an arc with an arbitrary radius that will intersect the arc made above.
5. Connect two lines from each end of the line L through this point of intersecting arcs.
6. Measure off equal distances on the other side of the point of intersection equal to the length from the end of line L, and the other two points of the parallelogram will have been determined.

Also solved by E. R. Leroy, Irving L. Hopkins, R. Robinson Rowe, William Butler, Jr., Jacob Bergmann, Scott Byron, John Rule, Doug Szper, Harry Zaremba, Winslow Hartford, and the proposer, John Rule.

Better Late Than Never

NS 6 Irving Hale claims to have an alternative solution:

It is true that the ages given in Mr. Blake's solution are correct, but it appears that they are not the only possible combination. They are based on the assumption that the youngest crew members are Peter, Moses, and Abel; but this is not specified in the problem. There are three other possible combinations: that the youngest are Joseph, Moses, and Abel; Joseph, Peter, and Abel; or Joseph, Peter, and Moses. Running the algebra on these combinations results in Peter being −2 years old and 0 years old for combinations 3 and 4, respectively; but for combination 2 (Joseph, Moses, and Abel) the answer is that Peter is 56 and the skipper 83, a result that seems to be consistent with the terms of the problem. My algebra on the two workable age combinations:

Let S = Skipper's age
J = First Mate Joseph's age = 41
P = Navigator Peter's age
M = Deck hand Moses' age = 27
A = Cook Abel's age = 28

$S = 2([J + (P + 14) + M + A]/4)$
$= \frac{1}{2}(J + P + M + A + 14)$
$= \frac{1}{2}(41 + P + 27 + 28 + 14)$
$= \frac{1}{2}P + 55.$

Case I (assuming the three youngest are Peter, Moses, and Abel):

$S + 13 = P + M + A$
$= P + 27 + 28$
$S = P + 55 - 13;$
therefore $\frac{1}{2}P + 55 = P + 42$; $P = 26$;
therefore $S = 68$.

Case III (assuming the three youngest are Peter, Moses and Abel):

$S + 13 = J + M + A$
$S = 41 + 27 + 28 - 13 = 83$; therefore
$83 = \frac{1}{2}P + 55$, and $P = 56$.

The problem is lovely; certainly the amount of information it generates is

awesome. I suspect that the terms of the puzzle could merely be changed to say that the crew voted in the last election and make some sort of subtle reference to "old" Joseph, to eliminate him from the three youngest members.

Additional responses have come as follows:
1977 JUN 2 Stephen Root.
1977 JUN 3 David Ross.
1977 O/N 1 Jerome Gordon and Ruth Turner.
O/N 2 Ed Lynch.
O/N 3 P. Clavier, Ed Lynch, and David Simen.
O/N 4 P. Clavier, Harry Zantopulas, John Rule, Benjamin Rouben, Timothy Maloney, and Leslie Carey.
O/N 5 Neil Hopkins and David Simen.
Y 1977 John Gratwick.

Proposers' Solutions to Speed Problems

M/A SD 1 It is well known that all the routes down a talus pile are irrational. The irrationals form an uncountable infinity.

M/A SD 2 For the evader, $x_e(t) = x_o + et$. For the pursuer, $x_p(t) = pt$. Capture then occurs at $t^* = x_o/(p - e) = x_{o/p}(1 - \alpha) = t_o/(1 - \alpha)$. The location for capture is $x_p(t^*) - x_o/(1 - \alpha) = x^*$. The condition on α for capture is $\alpha < 1$.

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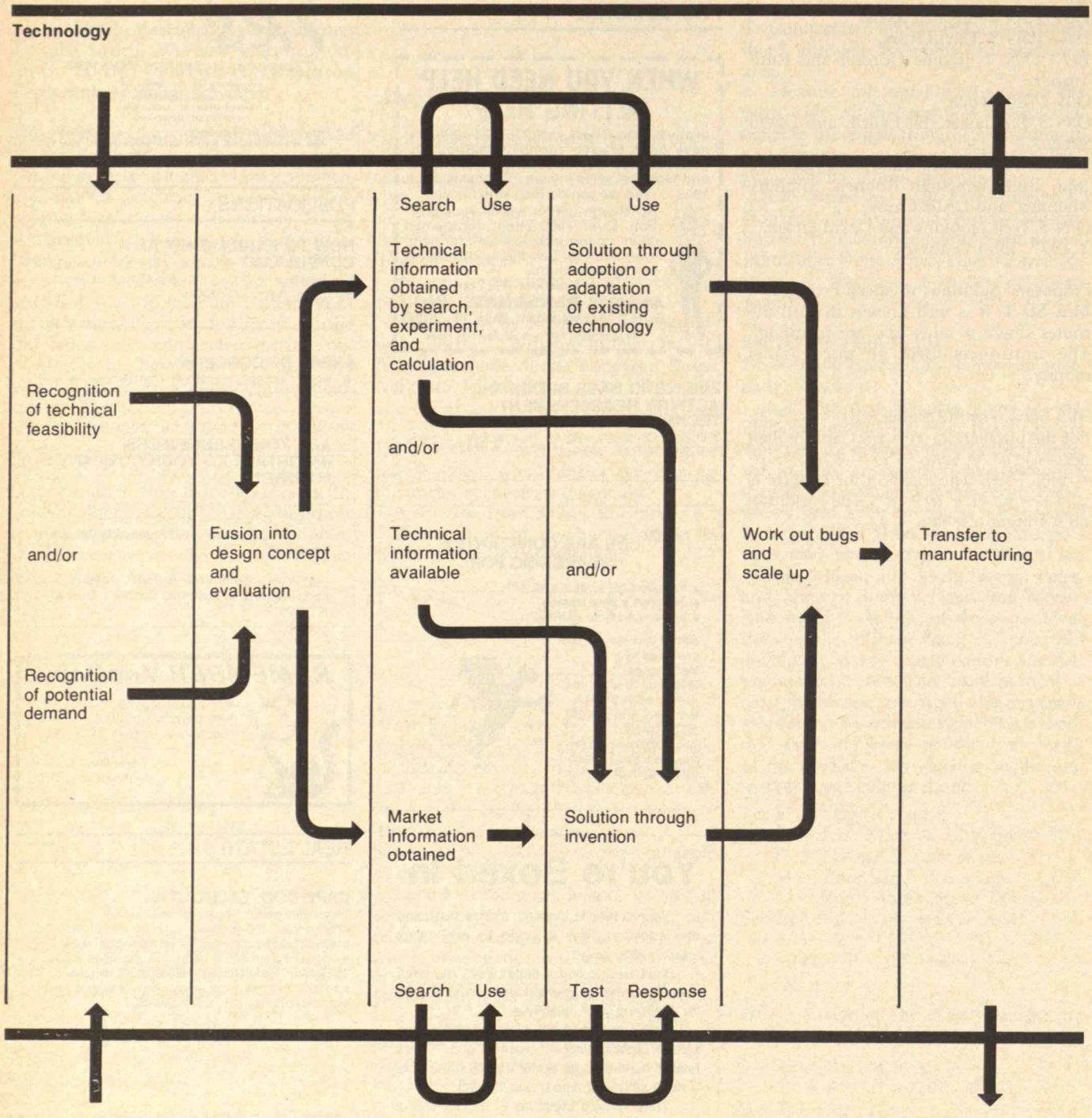
Innovation!


Technology
Search
Use
Use
Technical information obtained by search, experiment, and calculation
Solution through adoption or adaptation of existing technology
Recognition of technical feasibility
and/or
Fusion into design concept and evaluation
Technical information available
and/or
Work out bugs and scale up
Transfer to manufacturing
Recognition of potential demand
Market information obtained
Solution through invention
Search
Use
Test
Response
Market
1
Recognition of opportunity
2
Idea formulation
3
Problem solving
4
Prototype solution
5
Commercial development
6
Technology utilization and/or diffusion

Strategies for Improving Research Utilization

Much technically excellent research is never used. Careful research has uncovered a variety of strategies to overcome this problem.

Edward B. Roberts
M.I.T.

Alan L. Frohman
Boston University

Chart at left:
The several possible paths of innovation do not work equally well. Some pathways (market information generation, for example) need to be used continuously throughout the process. Others (solution through adoption or adaptation of existing technology) are highly effective in some innovation attempts, but irrelevant to other cases. Omitted for the sake of simplicity are the numerous feedback loops from later to earlier stages; these reflect the true iterative character of the innovation process. The original version of this diagram appeared in Myers and Marquis, *Successful Commercial Innovations*. We have added more detail to reflect our perception of the importance of market-related inputs to effective product/process change, while also indicating the multiple interactions between the "world of technology" and a company's or government agency's research and development efforts.

Technological innovation is implemented and adopted through a series of phases. Someone first has an idea; if it's good, the idea goes through a technical problem-solving stage before advancing to design and development. Finally if it fills a significant social need, the new product is utilized and diffused throughout the market.

Efforts to increase the number of research projects that result in successful new products — what we shall call "research utilization" — usually begin by examining the results of technical problem-solving, product development, or even production engineering to find the impediments to research utilization. A better approach is to alter the earlier stages of the entire innovation process in order to achieve new products or processes that are more likely to be used.

A New Perspective for Research-Based Innovators

Shifts in many facets of the industrial research organization over the last ten years — size, structure, charter, manpower mix, and type of leader — have resulted from the need to make better use of laboratory research results. The scope of the changes now encompasses technical and nontechnical problems and issues, and places still larger demands upon the technical staff. We shall discuss these changes in terms of objectives, activities, and staffing.

☐ *Shift in objectives.* Ten years ago, a central research organization's goals were "solving technical problems," "pushing ahead the frontiers of science," and "contributing to corporate goals through the generation of new ideas leading to novel technology." The prevalent assumption at the time was that generating "good science" would lead to new technology that could be marketed to some eternally grateful customer. So central research labs were a haven for scientists and engineers oriented toward scientific or technical accomplishment. Labs engaged in few research utilization activities, and when they did, these were limited to publications, symposia, speeches, and the like — scientifically acceptable activities suited to scientific audiences. The interplay between non-technical units of the company and central research was limited.

With increasing emphasis on the relevance of research in the late 1960s, the industrial lab's objectives shifted from furthering scientific goals to satisfying market needs. Labs lost kinship with academic departments in attempting to mimic embryonic technical, market-oriented businesses. The ivy was swept from the walls and replaced by large panoramic windows through which the researchers could see and be seen. Although some significant basic research and development is still carried out, the emphasis on this is far less now than in the past. The goals of a research organization became those of "developing new products" and "starting new businesses."

☐ *Shift in activities.* With the shift in objectives came a new set of activities. When scientific research and problem-solving dominated, management techniques (formalized plans and goals, control systems) and marketing issues (market research, competitive pressures) were considered irrelevant. Each scientist was a potential creative genius who would only be hampered by the ties of an organization's practices and policies. But, in the quest for

Nothing transfers enthusiasm so well as working with or watching a person who has faith, conviction, and excitement about an idea.

Illustrations: Cameron Gerlach

relevance these shibboleths were vanquished too.

New environmental pressures (new regulations, changing raw material supplies, etc.) and new market needs required planning by research managers. A few major research labs now have gone so far as to hire market research firms to examine potential new products. Research labs started to test the limits of their charters. Some brought product prototypes into the marketplace in order to acquire enough data to convince management of a new product's merit. More and more often, economic, market, and other non-technical analyses were necessary to check the viability of a new product or process. Sometimes these tests were carried out at an early stage of development, before a potential new product received the internal support of the research managers. Researchers' roles also shifted; they became the "salespeople of technology." The myth that technology sells itself on its own merits or that "new" technology is inherently "good" was exploded. Researchers wishing to see the fruits of their labors utilized had to sell the seeds.

Activities to enhance industrial research utilization also shifted from passive to active, and were made formal with special procedures and arrangements — project teams, integrators, and personnel transfers — to facilitate transfer of research outputs. Research organizations, realizing that good will and good relations do more for technology utilization than any other factor, sought to develop better "customer" relations even in the absence of a technology to push. Several organizations carried out "user seminars" on topics of interest to potential users and provided other services to promote customer good will.

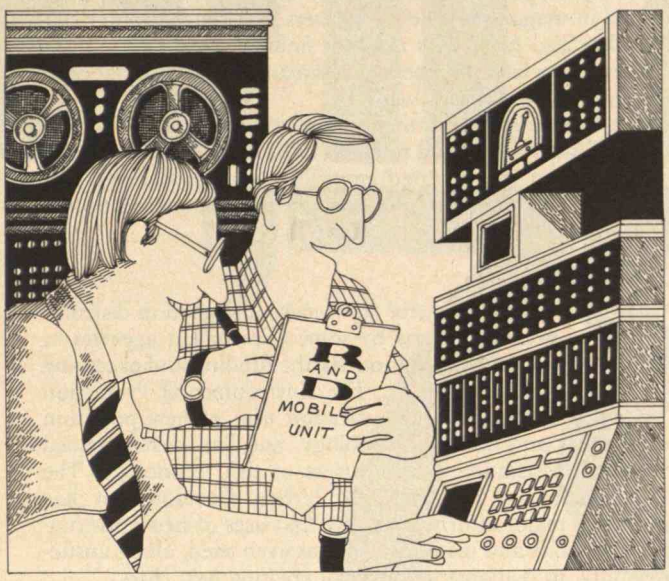
☐ *Shift in the mix and balance of skills.* As demand for relevance increased, it became painfully obvious to many research managers that their teams were incomplete. The emphasis on the generation rather than the use of research had narrowed the lab's range of functions. While the creative scientists/engineers were best able to generate ideas, they were rarely the most appropriate people to argue persuasively for their ideas to top management, manage a diverse group of people, recognize the need for business, finance, and marketing involvement and enlist those groups effectively, and handle the applications-oriented period of the project. As a result, research labs started hiring more engineers — in many cases engineers with a strong financial or business aptitude. More and more labs hired marketing-oriented personnel to supplement the skills of their technical personnel. As a consequence, the balance of skills has shifted from idea generation to idea utilization, and the mix now includes marketing, business, and finance skills. *(See the discussion of "critical functions" in Professor Roberts' article in this series, "Generating Effective Corporate Innovation,"* Technology Review, *October/November, 1977, pp. 26-33.)*

The Fruits of Relevance

The increased emphasis on application rather than creation of research results is reflected in a less "academic" approach to science in industrial research organizations. Significant shifts in research activities — more emphasis on the "selling of technology," early user involvement, and new types of skills brought in to supplement the creative scientist/engineer — are consistent with these changes in emphasis. Industrial research organizations have also undertaken other new approaches to research utilization.

Three general approaches have been used by industrial research organizations to facilitate utilization. The most effective approach is person-to-person contact, while procedural and organizational link-pin approaches require interactions among personnel from the various organizations who have a stake in the outcome of the work.

☐ *Personnel approaches.* The movement of people, joint teams, and geographical positioning permits intensive person-to-person contact between the generator and user of the research. These activities are the most effective in promoting understanding, acceptance and utilization of research results. As explained by Brian Quinn and James Mueller in their classic article on the topic: "A new product is like a baby. You can't just bring it into the world and expect it to grow up and be a success. It needs a mother (enthusiasm) to love it and keep it going when things are tough. It needs a pediatrician (expert information and technical skills) to solve the problems the mother



can't cope with alone. And it needs a father (authority with resources) to feed it and house it. Without any one of these the baby may still turn out all right, but its chances of survival are a lot lower."

The most difficult of the three to transfer is enthusiasm — a thoroughly person-to-person commodity. Nothing transfers enthusiasm so well as working with or watching a person who has faith, conviction, and excitement about an idea.

When a research result is to be transferred, movement of project personnel is a key factor in the project's survival through the tortuous journey toward manufacturing or the market. Those who worked with the project in the past are best able to assist in the adaptation of research results to specific "customer" needs.

Some industrial research organizations bring into the research lab some project personnel from the receiving unit and later transfer them with some of their own personnel into manufacturing. Personnel from the receiving unit (or units) have special sensitivities to the marketplace, technology, corporate directions, and so forth. And they possess skills in marketing, finance, business, manufacturing, and the like that are critical for answers to the technical and non-technical questions that management decisionmakers who allocate resources must ask. The key questions of economic viability (competition, cost of materials, return on investment), market scope (size, segmentation, location), legal issues, and so on can be answered by teams composed of people with this kind of mix of skills and sensitivities, regardless of the source of the personnel.

Geographic proximity also contributes to the probability of successful technology transfer. Communication decreases markedly with increasing distance, and with decreased communication comes diminished understanding, diminished trust, and greater resistance to the thrusts of the "outside" organization. Hence industrial research organizations have found that co-location with the receiving unit, either by the housing of personnel under one roof or the total movement of the laboratory into closer proximity, facilitates the development of a relationship and aids utilization of their research results.

□ *Procedural approaches*. Procedural bridges are exemplified by joint planning, joint funding, and joint appraisal of research. These strategies are less popular now in industrial research organizations because all too often they merely raise differences without providing adequate mechanisms for their resolution.

Joint funding alone has been found to be of little value. Industrial experience indicates that sharing costs creates expectations that are difficult to fulfill. The resulting disappointment leaves no one satisfied. Joint planning requires an intensive follow-up effort. Without the commitment and resources to maintain close contact throughout the project, joint planning does not contribute measurably to successful utilization.

Open, frequent, and regular joint appraisals by all the parties who feel they have a stake in the research (those without a real stake excluded) can be useful when coupled with regular project-related interactions by the project personnel.

One industrial research lab that was having difficulty transferring its research output to the product lines found this approach successful. The projects involved research, engineering, and the product-line divisions. A joint project team was composed of working-level members from each of the three divisions. A product-line team member, whose division would ultimately carry the project through, was made project manager. He reported to a coordinating board on which sat one member of each division, who stood at a level just under division manager. In other words, each division's representative had broad resource allocation and decisionmaking authority. The coordinating board met monthly to evaluate project progress. This bi-level joint staffing and evaluation approach has proven extremely effective in facilitating cooperation and timely decisionmaking.

□ *Organizational link-pins*. These approaches are especially useful and sometimes necessary for new ideas outside of the company's existing product lines or processes. Examples include: specialized transfer groups that contain engineering, marketing, and financial skills; the use of integrators who act as third-party transfer coor-

How Federal Agencies Approach Research Utilization

Federal agencies have experimented with and used numerous approaches in their attempts to enhance the commercial use of their research results. They range from passive mechanisms, such as data retrieval centers, to active strategies, and even to redefining the role of the commercial sponsorship of products. Most of the federal approaches have been ineffective in stimulating the diffusion of technological innovation.

Spreading the Word

Highest in frequency and expense, yet lowest in impact, are the numerous information dissemination programs. The Department of Defense Documentation Center (D.D.C.) collects Defense Department contractor and in-house research and development reports, and publishes and distributes periodic lists of report titles. Qualified subscribers to D.D.C. services can request copies of the reports when security and proprietary interests permit. D.D.C. provides no other port of entry to its massive library of defense technology information. In a similarly passive fashion, H.E.W.'s National Library of Medicine permits computer-accessed information search and retrieval of its vast files of biological research reports. The Department of Commerce National Technical Information Service furnishes copies of unclassified and unrestricted documents produced by federal research and development projects, thereby centralizing a library of materials largely duplicated elsewhere.

A related information dissemination activity is N.A.S.A.'s distribution of S.T.A.R. reports and I.A.A. abstracts, library-oriented aerospace research functions. Even less vigorous attempts are made by the Science Information Exchange (run under contract by the Smithsonian Institution) which limits itself to a referral, not even retrieval, function; the Small Business Administration merely passes on small business requests for data and documents to other agencies — often without success.

The Atomic Energy Commission (now part of the Department of Energy) has long disseminated its unclassified research and development results that might have industrial applicability through report distribution, manuals, technical information packets, and special purpose seminars.

The Department of Agriculture, rather than limiting itself to distributing scientific reports, has translated its research results into practical bulletins for the general public, published in magazines read by farmers and ranchers. Agriculture has also pushed its research findings through the mass media, using large numbers of radio and TV farm broadcasts as the communications vehicle.

All these federal information dissemination activities have led to little documented research utilization. This is not surprising given the repeated empirical research findings that demonstrate the ineffectiveness of written communication as a medium for technology transfer.

Show and Tell

Very different in character from mere information distribution have been the efforts by some government agencies to encourage research utilization via the funding and executing of demonstration projects. The Environmental Protection Agency has financed demonstration uses of new pollution abatement and control technology, and has even provided technical assistance to early users of this technology. The Department of Housing and Urban Development has launched major efforts to finance first uses of new construction methods and materials and has even tried, albeit unsuccessfully, to demonstrate ways of creating new cities.

Of special note is the Department of Agriculture's "permanent" institutionalization of the demonstration project. U.S.D.A. has established a national network of field stations and pilot research farms that provide ongoing research trials, in the local environment and with soil and weather conditions that are shared with the local prospective research-utilizing farmer. The continuing character of such field operations provides far more convincing evidence to the hesitant research user than does a one-shot demonstration.

Applications Engineering

At least two federal agencies have realized that effective industrial diffusion of their research results requires a strong

dinators; and new venture groups who look for and nurture new ideas. The groups operate to smooth the process through which a fragile new idea is turned into an applied product or process. They become the "nurturing" organizations for the new idea after technical feasibility has been established. They become the father, mother, and pediatrician for the idea until it can battle for its own life.

Organizational link-pins are successful if the idea generators see them as means to promote research utilization, not as an additional obstacle the idea must get around. To promote research exploitation effectively, the members of the new ventures or integrating units need to associate with the research project at an early stage and assist in focusing and problem-solving. If they come in near the end, they will be perceived inevitably as evaluators and nay-sayers. The experience of companies which have set up organizational link-pins demonstrates that link-pins must work closely with the idea generators, as a resource to them, from the start.

Several studies have provided persuasive evidence that market needs, rather than technological opportunities, are the main source for research projects with a high probability of utilization. Sumner Myers and Donald Marquis found that 75 per cent of the innovations judged most important by the company originated in response to perceived needs in the marketplace rather than from new technical potential.

Market factors and user needs are important in determining what technical problems to work on and what a "utilizable" solution to those problems will be. This argues for clear identification of the user, his or her needs, and the user's reaction to types of technological solutions *before* the technological problem-solving occurs.

Three pitfalls characterize the less effective approaches to research utilization, and an equal number characterizes the more effective approaches. We review them here:

☐ *Over-reliance on change motivated by new information.* The ultimate objective of achieving research utilization is a behavioral change on the part of the potential user. A rational approach to provoking this sort of

MIT '78

Articles

Departments

Independent Activities Period: A Unanimously Favorable Report from the Educational Policymakers

Folderol? Idle play? Unlimited opportunity for the student with initiative?

M.I.T.'s month-long January Independent Activities Period — now eight years old — has raised controversy every time around.

The Commission on M.I.T. Education wrote in 1970 that "the general environment at M.I.T. is too narrow; it does not adequately encourage or sustain humane learning in the fullest sense of the term." The solution to this problem was to set aside a time for students to delve into wider interests — to learn modern Irish; about nuclear power, horse race handicapping, impact analysis; or try modern dance, for instance.

The mid-year hiatus was begun as an experiment; three years later in 1973 the faculty voted to continue I.A.P. as an integral part of the Institute's regular academic calendar. But the Committee on Educational policy asked that in four years the I.A.P. Policy Committee submit an analysis of its worth. Their report:

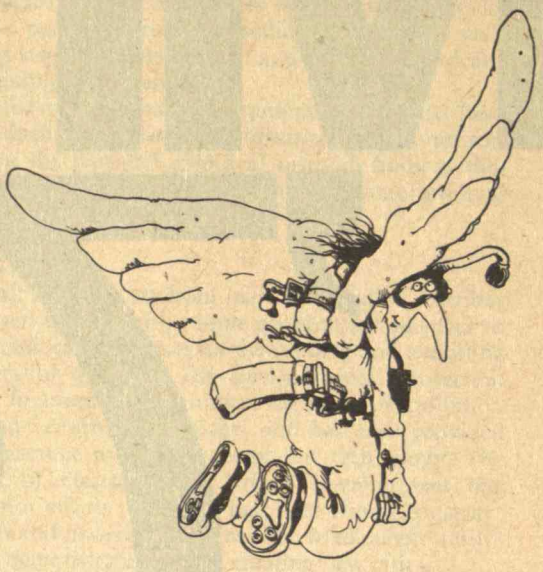
The original objectives continue to be met: "Elimination of the January 'lame-duck' period; easing of the between semesters rush; provision of fallow time for independent study and research; and provision of opportunities for flexibility in learning and teaching."

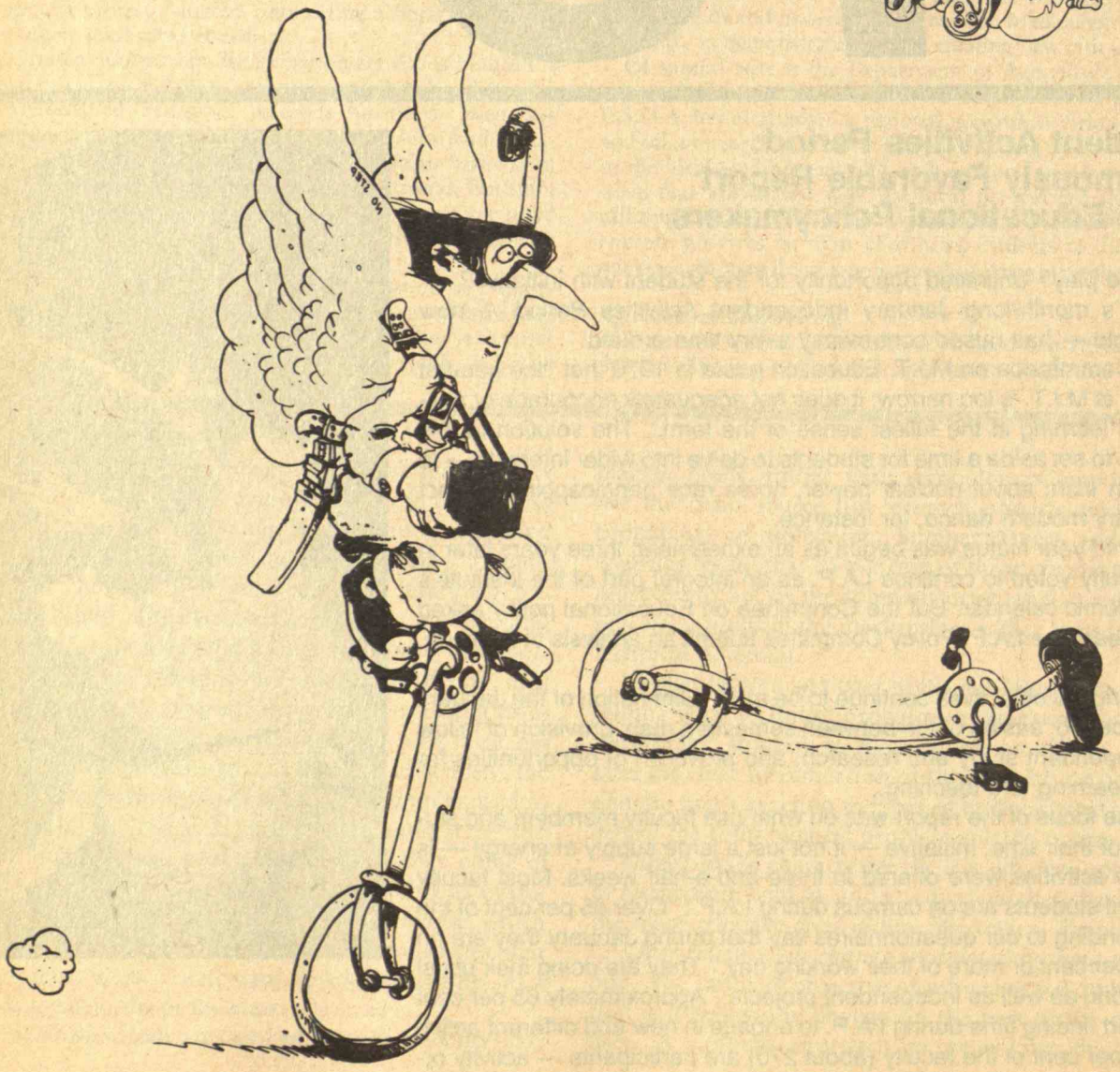
But the focus of the report was on what use faculty members and students make of their time. Initiative — if not just a large supply of energy — is needed: 520 activities were offered in three-and-a-half weeks. Most faculty members and students are on campus during I.A.P.: "Over 85 per cent of the faculty responding to our questionnaires say that during January they are on campus 75 per cent or more of their working day." They are doing their usual academic work, as well as independent projects. "Approximately 65 per cent of them report finding time during I.A.P. to engage in new and different activities." Thirty per cent of the faculty (about 270) are participants — activity or-

A Soap Bubble Carnival was complete with carnival music, red-robed, bubble-blowing hosts, gigantic soap bubbles . . . (Photo: Calvin Campbell)

Meet the "I.A.P. Person" — a student laden with camera, snorkel, running shoes, and slide rule, fiercely pedaling a unicycle to gain the acceleration needed to lift off on homemade wings (he does, finally). I.A.P. is a time to try one's wings — and at relatively low risk because commitments are provisional and short-term.

Kidnappers absconded with a huge cardboard cutout of the I.A.P. Person, created by Jon McIntosh, displayed in the lobby of Building 7. A letter soon appeared in The Tech *with demands to be met by midnight of the last day of I.A.P. First on the list: I.A.P. must be extended 30 more days.*





Steven McLain, a graduate student in chemistry, was one of many participants in an I.A.P. glassblowing course taught by Stanley R. Mitchell, a technical instructor in chemical engineering. (Photo: Calvin Campbell)

ganizers, seminar leaders, lecturers, panel members. And it is not the same group each year — "in any one year from 40 per cent to 50 per cent of the faculty were different from those of the preceding year. . . .

An important benefit faculty members cite: increased opportunities they have for one-to-one contact with students in research projects and informal activities. They "experiment with teaching methods and explore new topics, while departments use I.A.P. to try out new course materials or teaching arrangements. . ."

"For most students," the report continues, "I.A.P. is the only time they are at the Institute without continuing commitments and are thus free to explore the resources of the Institute for whatever individual goals, academic or personal, they choose. . . .

"During I.A.P. students also initiate and plan teaching programs, thus developing untapped leadership and organizational skills."

And in this casual atmosphere students often make their first attempt at research. In at least one instance, a short-term effort evolved into a continuing commitment. "One undergraduate became so interested in a study of surface acoustic wave devices which he started as a sophomore during I.A.P. that he continued it as a U.R.O.P (Undergraduate Research Opportunities Program) project . . . and it eventually became his senior thesis."

Student attitudes? I.A.P. continues to be favored. "Well over 90 per cent of undergraduate students think I.A.P. is a good idea, not only personally but also for the Institute as a whole, and this level of approval has been consistent since the first I.A.P."

"You've got it, don't waste it," writes William Lasser, '78, in *The Tech.* Not that the month must be spent doing research, studying language, or ensconced in a laboratory. The decision how to spend the time is a personal one — and perhaps instead of taking advantage of all the activities, spending the time making money, or doing nothing but existing on a more relaxed daily schedule than during the rest of the school year are legitimate I.A.P. activities, he suggests.

The Committee's conclusion is a positive one: ". . . This is a rare opportunity for the young or the not-so-young, for the apprentice or the journeyman. For many, I.A.P. has expanded horizons and opened up new areas of knowledge or new interests and avocations. For some, it has led to entirely new choices for first and even second careers. . ." They suggest, then, that the academic calendar continue to include I.A.P. — and that it should be again reviewed in four years. — *M.L.*

The decision how to spend the time is a personal one — and perhaps instead of taking advantage of all the activities, spending the time making money, or doing nothing but existing on a more relaxed daily schedule than during the rest of the school year are legitimate I.A.P. activities.

When two bubbles come together, the surface between them (a) is flat, (b) sags into the small bubble, (c) sags into the big bubble.

Soap Bubbles . . . Thermodynamics . . . Energy . . . Jazz Dancing

The M.I.T. community in the month of January is so bustling it's hard to see into every nook and cranny where groups of students and faculty are engaged in greatly varied — often seemingly bizarre — activities. Some vignettes:

As one walks through the lobby of Building 7, a 300-pound block of ice looms above the crowd. It is a contest — how long will it take to melt? There were 718 guesses; the answer: from 9 a.m. on Monday, January 23, to 5:30 a.m. on Friday, January 27. The winner, Fred Sims, was only four minutes off — he predicted 5:34 a.m.

A "Soap Bubble Carnival" packed Room 66-110, complete with carnival music, red-robed, bubble-blowing hosts, gigantic soap bubbles floating as their creators were cheered on, and a contest with questions about the mathematical principles to explain the behavior of soap bubbles. Sample question: "When two bubbles come together, the surface between them (a) is flat, (b) sags into the small bubble, (c) sags into the big bubble." Dr. Frank Morgan, mathematics instructor, was the originator and ringmaster; Professor Harold E. Edgerton, Sc.D.'31, costumed for the occasion, explained the bubbles' behavior as his assistants created them. The prize for the quiz winners: yes, bubble blowers and soap. And for the carnival's conclusion, a film of bullets piercing soap bubbles, followed by Dr. Edgerton leading the audience in a rousing chorus: "I'm Forever Blowing Bubbles."

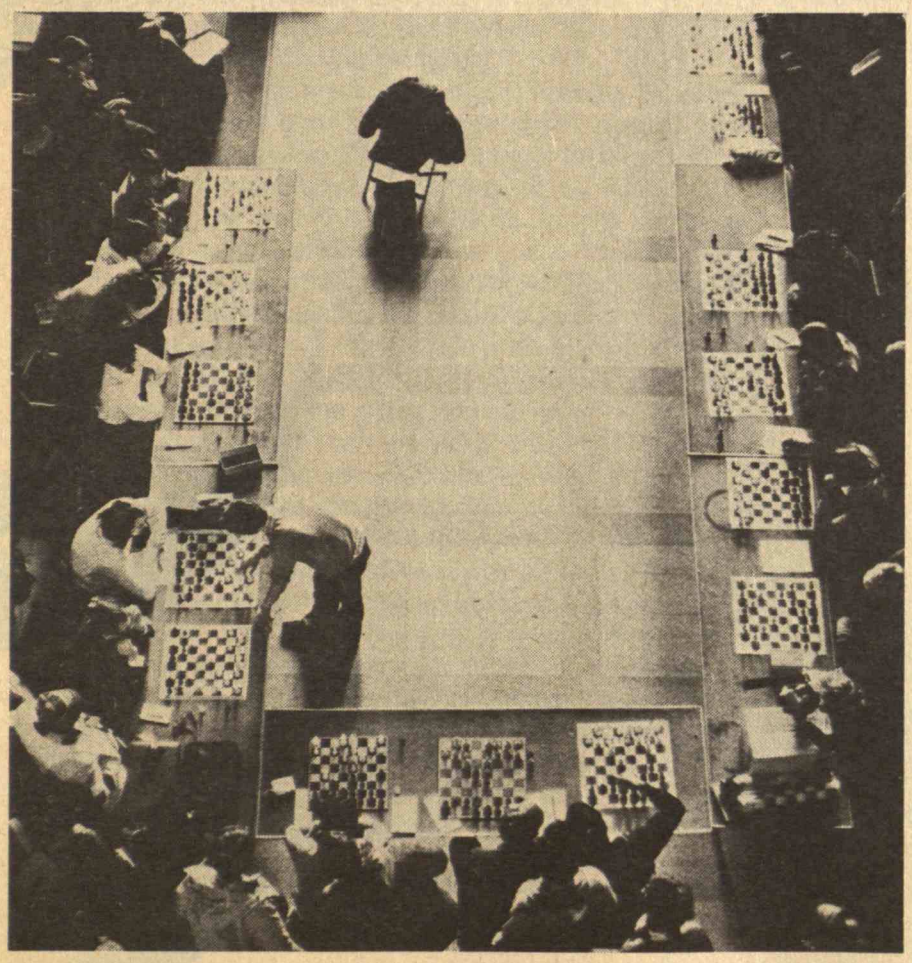
Some groups got together to pursue the same interest — eight musicians spent January practicing 15th-century Flemish music on instruments of the period and gave a free concert on the last day of I.A.P.

A severe blood shortage in Greater Boston prompted the Technology Community Association to schedule a blood drive during I.A.P. 1978. The result: 254 pints for area hospitals severely short after the holidays.

William T. Kennedy, who used to teach physics at M.I.T. before he became nationally known as a yoga educator, returned to give 75 students a course in yoga techniques related to the "relaxation response." "I want to teach undergraduates to relax at will," he told Steven Solnick, '81, of *The Tech*.

Some 256 students and employees signed up for the written examination phase of the I.A.P. "College Bowl" contest. Then four teams were picked for the finals, and a delegation from Russian House (the Russian-speaking corridor in the New West Campus Houses) was the winner. Tough questions; here's a sample offered as a lure for next year's contest: "If Gargantua, the legendary giant of Rabelais, were to sign a major league baseball contract, he would — of course — sign with the Giants. Who would the following play for? — Jean Lafitte, Vladimir Ulyanov, Father Junipero Serra, Chang and Eng Bunker, and Hester Prynne." The answers: Pirates, Reds, Padres, Twins, and A's.

For a full week of I.A.P., the Boston Repertory Ballet held master classes and lecture/demonstrations. After this exposure to the "behind-the-scenes" of this remarkable profession, scores of members of the community were better prepared for the Ballet's full peformance in Kresge Auditorium on January 27.



A popular I.A.P. offering was Horse Race Handicapping; students' visages (opposite page, top) varied from puzzlement skepticism, and concern to elation. Huge soap bubbles delighted the audience of the Soap Bubble Carnival (opposite page, middle); its circus atmosphere was enhanced by a red-robed Professor Harold E. Edgerton (opposite page, bottom right). Elizabeth Soenarjati displays a puppet from Java (opposite page, bottom); she demonstrated Indonesian puppet plays and described their relationship to court dances. Building 7 lobby was filled with chess players (left), all facing the same opponent: Kenneth S. Rogoff, the fifth-ranked chess player in the United States. (Photos: Calvin Campbell)

Alive and Well and Living in Cambridge — Despite the Blizzard

by William Lasser, '78

When the "Blizzard of '78" left over two feet of snow groomed into immense drifts with 70-mile-an-hour winds, everything in eastern Massachusetts shut down for almost a week. There were no classes at M.I.T. from February 7 through 10, and a network of chartered buses was finally used to bring faculty and staff into Cambridge so that classes could meet on February 13 and 14.

"Awesome!" was Governor Michael Dukakis' description of the storm and its effects, and similar expressions were being used by virtually all of the M.I.T. community to describe the storm — and the performance of the Physical Plant staff, students, and others in digging the Institute out from under the mammoth drifts of snow and in keeping essential services operating. "They did a helluva job," *Tech Talk* proclaimed loudly.

Students, trapped for the most part in dormitories and fraternities, were scheduled to begin the new term on Tuesday but instead found themselves fighting "cabin fever" and influenza, both of which reached near-epidemic proportions in some living groups. By Thursday, the storm ended, streets and sidewalks were being opened for pedestrians and students began walking to grocery stores, building snow sculptures, and inventing new and different ways to pass the time.

Many students performed vital services around M.I.T. — staffing and managing food service operations in the absence of regular personnel, and, of course, shovelling snow, both on and off campus. Groups of students shovelled out the Cambridge Salvation Army Headquarters and other important medical and relief centers. And large numbers volunteered to shovel for Physical Plant, many expecting no pay. But Lawrence W. Pickard, Manager of Physical Plant's Grounds Services, would have nothing of it, telling students "if you work for me you get paid."

Mr. Pickard, who arrived at work on Monday, February 6 at 6 a.m. in order to begin planning for the expected storm, remained in charge of the Physical Plant operation all week, grabbing a few hours of sleep whenever and wherever he could, going home finally at 11 Friday night. "It was unbelievable, really," he said of both the storm and the community's response. "The mood on campus was great."

Despite all the problems facing him, Mr. Pickard was sensitive to the needs and wants of students. A group of hockey enthusiasts asked him to open up the skating rink — a task which was understandably low on his list of priorities. Mr. Pickard responded by handing out shovels and a few snowblowers and letting the skaters do the work themselves.

The staff of *The Tech* provided the only written communications medium on campus, a service which proved vital in publicizing an emergency blood drive which netted almost 400 pints for blood-starved Massachusetts hospitals. *The Tech* provided the publicity with an unprecedented front-page advertisment. Equally unprecedented was a two-day delay in publishing the February 7 issue, which was held up because the paper's printer, located in hard-hit Revere, was unreachable by any form of transportation, except, finally, subway and cross-country skis. The Metropolitan District Commission gave verbal permission to *The Tech* to let staff members drive during the emergency in order to publish Friday's issue, which contained the blood drive information. The journalists were handed a citation by police cracking down on joyriders — but the paper came out on time. The Metropolitan District Commission assured the newspaper that the legal difficulties would be worked out.

The Lecture Series Committee, through equally heroic efforts, was able to provide movies for students on the weekend, creating a much-

Wellesley: Alive and Well While Spending a Disaster at M.I.T.

By Liza Ahearn
The following is reprinted by permission from The Beaver, *a student newspaper serving the M.I.T., Wellesley, and Simmons communities.*

Being snowed in with no school for a whole week is undoubtedly memorable. But for five girls snowed in at an M.I.T. fraternity — well, that's another story.

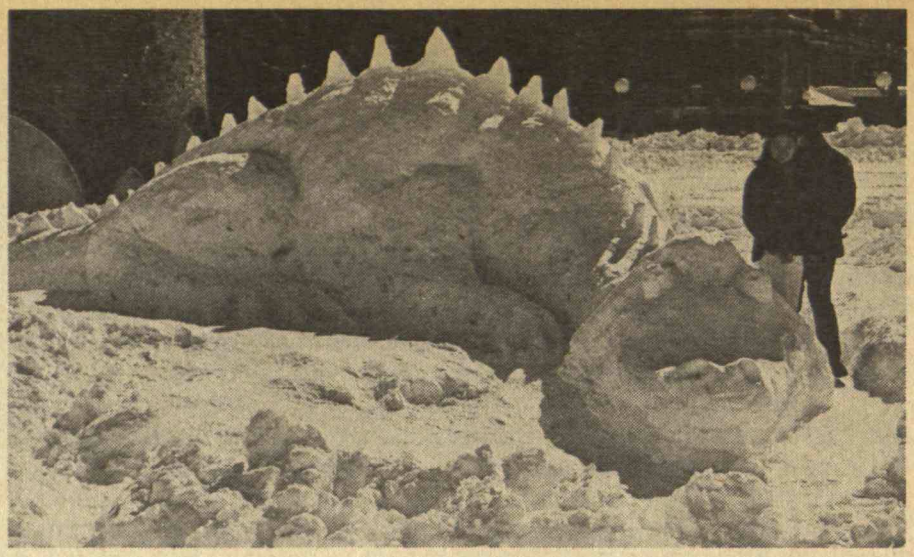
Two of the five had been shopping in Boston and — after registering at M.I.T. and never realizing that the 6:10 exchange bus would be the last to run — ended up eating dinner at the house. Not having any choice, they cheerfully accepted their fate — a night at the fraternity. But when Wednesday rolled around and there was no hope of getting back and school for Thursday had been called off, things began to look grim.

After all, they had few clothes and were in need of other major necessities. So three girls back at good old Wellesley decided to do their bit. Being quite stuffed to the gills with cinnamon popcorn and cocoa, and getting ill at the thought of getting *ahead* in schoolwork, the three of us threw emergency supplies into knapsacks and set out for Cambridge to bring relief. We made it to Kenmore Square without much mishap. In record time we arrived at the back door of the fraternity house. They were pretty surprised to see us, and there was a unanimous decision to celebrate. Well, the bar opened up and the piano got going and dinner was generally pretty lively (for a Wednesday night!). As it turned out, we ourselves became snowbound and ended up staying until Sunday. I must admit, though, despite lack of clothes and other female accountrements, we did pretty well.

One thing I noticed was the absence of mirrors. No major crisis, but for anything that required a mirror we had to trudge down to the bathroom, and even that had only a waist-up mirror. And while taking showers, we had the option of using the tried-and-true method of a tie on the door indicating occupancy.

The best thing, though, was getting to know a group of people I probably would never have known otherwise. Going to movies in a huge group, making snow sculptures, going to Father's and acting like lunatics (and not caring), and having snowball fights in the middle of Massachusetts Ave. were all memorable events. It was nice to let our hair down, so to speak, and not worry if we didn't look perfect, or wonder which line they'd use (and believe me, they have *quite* a repertoire), or if they'd ask for the good old phone number.

In any case, staying in a fraternity was fun and revealing, a great way to spend a disaster.



Photos: top right: Gordon R. Haff, '79; above: Stephen Finberg

needed diversion. L.S.C. had scheduled "Annie Hall," "One Flew Over the Cuckoo's Nest," and "The French Connection" but was unable to obtain prints from the usual supplier whose warehouse was closed by the storm. So two enterprising L.S.C. members took the operating subway to South Station, boarded Amtrak — the only way out of Boston — to New York, and brought back prints from suburban New Jersey to delighted M.I.T. audiences.

There were other examples of transportation-related heroics. At least six deliveries of pressurized gas cylinders were made to various M.I.T. researchers, including one by ambulance to the National Magnet Laboratory. Two employees of the Medical Department's Division of Animal Medicine walked miles each day to feed experimental animals. An unidentified student walked across the Longfellow Bridge in the midst of the blizzard to obtain medicine for an M.I.T. telephone operator. Campus Patrolman Jim Mahoney walked to work, from Woburn.

Two heroic employees kept the 24-hour Student Center Library open throughout the storm. Frederick A. Barstow of Forest Hills, who had the three-to-eleven (evening) shift, walked and rode as best he could — once hitching a ride on an M.B.T.A. work train; and Po DiPanfilo walked from Somerville to his eleven-to-seven shift. Some 3,300 users were in the Library during that siege.

Physical Plant's Assistant Foreman Oscar Manupelli arrived with Mr. Pickard Monday morning and was unable to return home until the following Monday afternoon. President Jerome B. Wiesner, like Boston's Mayor Kevin White, was caught out-of-town when the storm arrived and spent the week working in New York.

Students pitched in everywhere to help solve the critical problem of food. At Baker House, for example, when Beth L. Tufts, food supervisor, found herself snowbound at home in Billerica, students took charge — cooking, serving, and cleaning up through breakfast on Thursday. Then — despite asking everyone not to take seconds — they ran out of food. At that point Physical Plant loaned Food Services a truck and Campus Patrol provided escort services for a restocking expedition to Boston wholesalers; Randall E. Fahey, '79, used his four-wheel drive truck to pick up meat supplies.

The Campus Patrol, led by Chief Frank Olivieri and Lieutenant Marshall "Bud" Cheverie, worked closely with Physical Plant and with other emergency personnel. Uniformed officers accompanied Physical Plant trucks through police roadblocks to obtain food for the community. There were several frightening fire alarms, none of which proved serious. "We were very fortunate," said Olivieri. "Fire — that would have been tragic," added Lieutenant Cheverie.

Physical Plant's Pickard most succinctly summed up the Institute's survival. "It was a team effort," he said. "We were very lucky."

A $10 Million Fund for Engineering: New Faculty, Teaching, and Research

A $10 million fund to help the School of Engineering keep abreast of increased enrollment and new research and teaching opportunities was defined this winter within the $225 million Leadership Campaign. The goals:

☐ Increase the size of the engineering faculty by 30 to 50, mostly younger teachers who will provide the School with "an infusion of new ideas and talent" and help spread the teaching load resulting from continuing and dramatic increases in enrollment. The cost will be $3.5 million.

☐ Launch what Professor James D. Bruce, Sc.D. '64, who is acting as Dean of the School, calls an "urgently-needed curriculum renewal effort." He wants a program of systematic change in the content and method of teaching, especially in core subjects for undergraduates and professional subjects at the graduate level, supported by $2.5 million; wider use of modern technology — computers and television, for example — in teaching ($1 million); and $1.5 million in new equipment for use in classroom and laboratories.

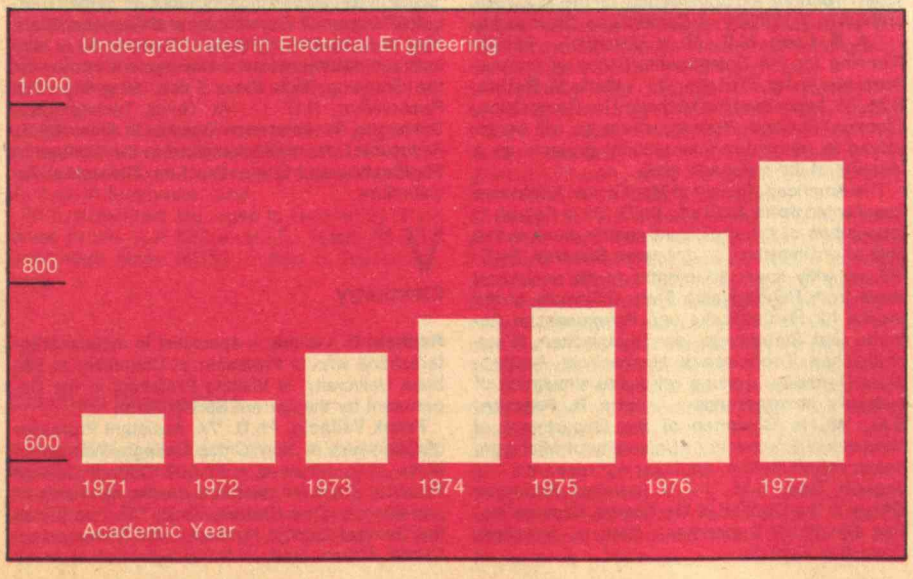
☐ Provide $1.5 million in seed funding for promising new research — especially cooperative, interdisciplinary projects — for which conventional research grants are unavailable.

Engineering is claiming sharply increasing interest among M.I.T. undergraduate and graduate students — so much so that President Jerome B. Wiesner describes the School as "besieged by new-found popularity." Undergraduate registration has grown from 1,800 in 1976-77 to over 2,000 this year; and Dean Bruce expects at least 2,200 sophomores, juniors, and seniors in 1978-79. Current graduate registration is 1,950.

Already the School is at work on a three-year experiment to develop School-wide subjects in fields which span the interests of many departments but are central to none — entrepreneurship, innovation, patent rights, law, economics, and energy policy, for examples. There's also an effort to develop new subjects that integrate knowledge from several disciplines.

And there is a new move to form "area committees" of faculty from departments which share certain basic engineering sciences — thermodynamics, structural mechanics, and fluid dynamics, for examples. The question is whether a single subject in thermodynamics, for instance, can effectively substitute for the several subjects now taught in that field by the several departments to whose work it is fundamental; or whether — at least — the several subjects in thermodynamics can be better coordinated and perhaps use the facilities of a single, superbly-equipped laboratory in place of the "deteriorating" facilities now available.

The engineering school is at work on a three-year experiment to develop school-wide subjects in fields which span the interests of many departments but are central to none — entrepreneurship, innovation, patent rights, law, economics, energy policy . . .



Nowhere in the School of Engineering is the dilemma of increasing enrollment and constant resources more pressing than in the Department of Electrical Engineering and Computer Science. The number of undergraduates choosing to major in that Department has gone up steadily — at the rate of 10 per cent a year — since 1972. Ten years ago, when undergraduate enrollment was 650, the electrical engineering faculty numbered about 160; now, with 950 majors, the faculty is about 115. Kent Pitman, '80, of The Tech *asked Professor James D. Bruce, Sc.D. '64, who is acting as Dean of the School of Engineering, about imposing a ceiling on future electrical engineering enrollment. Dean Bruce hopes not: "Institute policy is that students may elect their majors without restriction," he said, "and that is one of the great things about M.I.T."*

Courses

Though almost everyone in Cambridge has forgotten the Civil Engineering Department's Summer Surveying Camp in East Machias, Maine, there are plenty of local mementos in Washington County. One of them made the news this fall when Herbert Cleaves of the Bangor News *Machias Bureau discovered this bench mark on the wall of a Machias building now occupied by the Washington-Hancock Community Action Program. It certifies as of 1936 to the elevation of the line on the plaque — 33.59 feet above mean sea level — on what was then the Machias Post Office. There are scores of similar markers in the vicinity, says Mr. Cleaves — testimony to the number of surveys of Washington County made by generations of M.I.T. civil engineering students during a half-century of summer studies at that distant outpost. (Photo: William T. Vasquez from the* Bangor News*)*

I
Civil Engineering

Lew Thatcher, Sc.D. '72, has accepted an appointment to the faculty of the Polytechnic Institute of New York as Associate Research Professor of Civil and Environmental Engineering . . . President and Chief Executive Officer of Boyle Engineering Corporation, Newport Beach, Calif., **Thomas S. Maddock** S.M. '51, serves as a Captain in the Civil Engineer Corps of the U.S. Naval Reserve and is Chief-of-Staff of the Reserve Naval Construction Force . . . **Harry D. Gibbons,** S.M. '49, is Vice President and a Director of Engineering-Science, Inc., an international consulting engineering firm . . . **Tom Asselin,** S.M. '66, is a Senior Partner in the law firm of Walstad, Wickwire, Peterson, Gavin & Asselin, Washington, D.C., specializing in construction law and government contracts law . . . **Polyvios C. Vintiadis,** S.M. '61, has been elected a Vice President of Arthur D. Little, Inc., where he has been Managing Director of the firm's Middle East operations.

II
Mechanical Engineering

Arthur M. Spiro, S.M. '47, is President of A.M.S.-Tex Enterprises Inc., New York, N.Y., a company which defines opportunities for, finds, and markets textile technology . . . **Dwight E. Beach,** S.M. '65, is President of the American Aeronautics division of Weatherford International, Houston, Tex . . . **Charles Leeper,** Sc.D. '48, is Vice President — Engineering of the C.E. Air-preheater subsidiary of Combustion Engineering . . . **A. B. Lang,** M.E. '62, is Manager — Facility Planning for the Components Group of International Harvester, Chicago, Ill . . . **Mario M. Rathle,** S.M. '59, has joined the Michelin Tire Corporation, Clermont-Ferrand, France, where he will be involved in numerous international projects as a member of the corporate staff.

The American Society of Mechanical Engineers has elected **John A. Clark,** Sc.D. '53, a Fellow, in recognition of his significant contributions to the field of engineering . . . **J. Lowen Shearer,** Sc.D. '50, recently spent six months of his sabbatical leave from Pennsylvania State University at the Institut für Hydraulische und Pneumatische Antriebe und Steuerunge, der Rheinischen, Westphälischen Technischen Hochschule Aachen, West Germany, working on digital simulation of hydraulic servosystems . . . **John R. Pearson,** S.M. '46, is Chairman of the Department of Mechanical Engineering, University of Michigan, doing rehabilitation engineering research . . . **Joseph Ting,** S.M. '74, is Assistant Research Officer in the Division of Mechanical Engineering, Gas Dynamics Department, National Research Council of Canada.

III
Materials Science

Dennis W. Readey, Sc.D. '62, has joined the faculty of the Ceramic Engineering Department of Ohio State University as Associate Professor of Ceramic Engineering . . . **Thomas R. Clevenger, Jr.,** Sc.D. '61, has been named general manager of Far East/Pacific operations for Owens-Illinois, Inc., a leading worldwide producer of glass, paper, plastic, and metal products.

Dennis J. Carney, Sc.D. '49, has assumed the post of chief executive officer at Wheeling-Pittsburgh Steel Corp., the nation's ninth-largest steelmaker . . . **James F. Carlin, Jr.,** S.M. '62, has joined the U.S. Department of the Interior, Washington, D.C.

IV
Architecture

The U.S. Department of Housing and Urban Development has appointed **Justin Gray,** M.C.P. '52, as Deputy Assistant Secretary for Neighborhoods and Consumer Affairs in the Office of Neighborhoods, Voluntary Associations, and Consumer Protection . . . **Marvin Goody,** M.Arch. '51, has been reappointed Chairman of the Boston Art Commission . . . **Rai Y. Okamoto,** M.Arch. '51, is Director of Planning of the San Francisco City Planning Department.

Gregory Bassett, Jr., M.C.P. '48, is the Assistant Director of the Capital Improvements Program Branch, National Capital Planning Commission, Washington, D.C. . . . **Earl E. Stewart,** M.Arch. '53, is currently serving as Chairman of the Graduate Program in Community and Regional Planning at North Dakota State University; he is also active in natural resource managment studies for the Standing Rich Sioux Tribe, Standing Rich Reservation, N.D. . . . At Texas Technological University, **W. Lawrence Garvin,** M.Arch. '58, is Associate Dean of Architecture in the College of Engineering and Chairman of the Division of Architecture.

V
Chemistry

Raphael D. Levine, a specialist in molecular interactions who is Professor of Chemistry at Hebrew University, is Visiting Professor in the Department for the current Spring Term.

Frank Vellacio, Ph.D. '74, Assistant Professor of Chemistry at Holy Cross College, Worcester, Mass., has received a $6,000 Cottrell College Science Grant for research on the synthesis of proteins . . . **Carl Chalek,** Ph.D. '77, has joined the General Electric Research and Development Center, Schenectady, N.Y., as a physical chemist.

. . . The Lehigh Valley Section of the American Chemical Society has named **Donald W. Shive,** Ph.D. '69, as its Chairman-elect; he will succeed to the Chairmanship in December, 1978.

John Emmett Ellis, Ph.D. '71, has been promoted to Associate Professor of Chemistry at the University of Minnesota . . . **Tommy Ebe,** S.M. '70, Senior Associate Editor at Chemical Abstracts Service, has been elected President of the Chemical Notation Association . . . **Bruce A. Averill,** Ph.D. '73, is Assistant Professor in the Department of Chemistry at Michigan State University, East Lansing, Mich . . . **Eugene A. Burns,** Ph.D. '56, has joined Systems Science and Software, La Jolla, Calif., where he is forming a chemistry program.

Charles M. Apt., Ph.D. '52, has been appointed Manager of the Food and Agribusiness Section of Arthur D. Little, Inc. . . . Academic Press has published *Living Chemistry* — a textbook, student guide, and laboratory manual — by **David A. Ucko,** Ph.D. '72 . . . At Tulane University, **Joel T. Mague,** Ph.D. '65, is the Chairman of the Chemistry Department.

VI-A

Cooperative Program in Electrical Engineering and Computer Science

The VI-A Program is very happy to announce that Motorola, Inc. will be joining the Program in the spring of 1978. They will be recruiting for students to begin their assignments in June, 1978 with their Communications Group in Schaumburg, Ill. We are looking forward to this association especially as **William J. Weisz,** '48, President, is one of our alumni. Also employed there are **Joel H. Kulp,** '75, and **Lewis H. Rosenthal,** '73.

This will be the VI-A Program's 61st year of operation and it is anticipated that a record number of students will a apply. Interesting statistics will be reported in a later issue.

Other items of interest on VI-A graduates are: **David E. Abrams,** '76, is currently working for Thornton Associates, Waltham, Mass. . . . **Dale C. Flanders,** '73, tells us that he has submitted his doctoral thesis and expects to graduate in February, 1978. He has been doing his graduate work at Lincoln Laboratory . . . **Ira K. Gershkoff,** '73, stopped by the VI-A Office. He is currently a Transportation Analyst at the Onyx Corp. in Bethesda, Md.

We also had a surprise visit from **Robert F. Turek,** '70, and **Margaret (Rondio) Turek,** '72, accompanied by their young son who was born on October 16, 1977. Bob is a member of the technical staff of Systems Development Corp., McLean, Va.; Margaret is a Senior Systems Analyst with CTEC, Inc., Falls Church, Va.

VI-A is strongly represented at the Harvard Business School this year by **John D. Chisholm,** '75, **Thomas R. Crawford,** '76, **Barry Goldman,** '76, **Lawrence Kernan,** '76, and **Bosco K. Sun,** '73. . . . **Vincent H. Tobkin,** '73 graduated last June from the combined Harvard Business/Law School Program and is currently working in New York City.

Edward C. Giaimo, '74, is currently employed in Hewlett-Packard's General Systems Division of the Computer Systems Group in Cupertino, Calif. He lives in Sunnyvale, Calif.

VI-A alumni/nae are urged to send notes of interest to the VI-A Office, M.I.T., Room 38-473, Cambridge, Mass. 02139 — *John A. Tucker,* Director

X

Chemical Engineering

Arthur B. Metzner, Sc.D. '51, H. Fletcher Brown Professor and Chairperson of the Department of Chemical Engineering at the University of Delaware, has been honored with two prestigious national awards: the Society of Rheology of the American Institute of Physics presented Dr. Metzner with its 1977 Bingham Medal, and the American Institute of Chemical Engineers selected him to receive the Warren K. Lewis Award for Contributions to Chemical Engineering Education for 1977 . . . **Thomas H. Goodgame,** Sc.D. '53, Director of Environmental Control at Whirlpool Corporation in Benton Harbor, Mich., has been named a Fellow of the American Institute of Chemical Engineers.

Allan H. Bergman, S.M. '58, has been named Vice President and General Manager of Permabond International Corporation, a subsidiary of National Starch and Chemical Corporation, Bridgewater, N.J. . . . **Albert S. Humphrey,** S.M. '49, Chairman of Business Planning and Development of Coffenco International Ltd., has been appointed a Director of that company . . . At The Badger Company, Inc., Cambridge, Mass., a subsidiary of Raytheon: **Robert M. Langer,** S.M. '48, has been appointed Vice President, and **Robert E. Siegfried,** S.M. '47, has been elected Chairman and Chief Executive Officer.

XI

Urban Studies and Planning

The first of four projected volumes containing research reports of the project on Innovative Resource Planning in Urban Public Safety Systems has now been published by Lexington Books, Lexington, Mass. *Emergency Medical Systems Analysis: The Planning and Evaluation of Services* is edited by **Richard C. Larson,** '65, and **Thomas R. Willemain,** '72, who are both Associate Professors of Urban Studies. Three other volumes in the series will deal with police patrol deployment, police accountability, and police use of computer technology.

James Q. Cannon, M.C.P. '72, is Director of Planning and Analysis for Utah Profesional Standards Review Organization, a medical peer review body responsible for quality assurance . . . **Samuel A. Sherer,** M.C.P. '70, has started his own law firm, Topping and Sherer, in Washington, D.C., with one of its emphases on the problems of commercialization of new technology and another on neighborhood revitalization; he also works as an expert on planning, land tenure, mortgages and low-cost housing overseas, recently in Indonesia and Egypt.

XIII

Ocean Engineering

Three faculty appointments were announced early this winter:

☐ **Francis Noblesse,** for two years Research Associate in the Department of Aeronautics and Astronautics at Stanford University, has been named Assistant Professor. He studied at the Faculté des Sciences in France and holds graduate degrees from the University of Iowa.

☐ **Kiyohide Teral,** Manager of the Welding Research Laboratories at Kawasaki Heavy Industries, Inc., Japan, is Visiting Professor until September. Director of the Japanese Welding Engineering Society, he is a widely known authority on modern metal-joining techniques.

☐ **Robert J. Van Houten,** Ph.D. '76, has been promoted from Research Associate to Assistant Professor; he's been working with Professor Jerome H. Milgram, '61, on oil spill containment. Dr. Van Houten holds an undergraduate degree in naval architecture and a master's degree in administration, the latter earned while he was on active duty with the Coast Guard from 1968 to 1971.

Ira Dyer, '49, Head of the Department, is Chief Scientist of an international team conducting acoustic experiments in the Canadian Basin north of the North Slope this spring. The object of CANBARX — the Canadian Basin Acoustics Reverberation Experiment — is to learn how sound signals transmitted through the ocean are reflected and scattered from distant boundaries of the Basin, as far as 1,000 miles from the experiment site.

The Wizards vs. the Artisans; Science vs. Wishful Thinkers

Ancient Chinese goldsmiths developed a metallurgical test (the cupellation test) to distinguish gold from all other metals. But generations of Chinese emperors sponsored Taoist wizards who claimed the art of transmuting base metals into gold and proposed to use the same principle to transmute the corruptible human body into immortality. Had one of the artisans challenged the wizards by putting their so-called gold to the test, the fraud would have been discovered. But it never happened.

Why did no artisan rise to the challenge?

Imagine the odds against him if he had, speculates Professor James C. Wei, Sc.D. '55, new Head of the Department of Chemical Engineering, in a guest editorial in *Chemtech (September, 1977).* The emperor, seeking cheap gold and assured immortality, heard what he wanted to hear from his wizards; no artisan could expect a fair trial, and whatever he said would be taken as self-serving, job protection, the "not-invented-here" syndrome.

It's just like this in the U.S. today, says Professor Wei. We are asking if nuclear power is safe, if preservatives should be used in foods and insecticides on food plants, about recombinant research. Today's wizards tend to tell people what they want to hear. And today's artisans — engineers and scientists — find it hard to be admitted to court; they are dismissed as prejudiced and their testimony as self-serving.

The story of the Chinese emperors is attributed by Professor Wei to Professor Joseph Needham of Cambridge University, a historian of Chinese science and technology. Professor Wei has added the modern parallel: "Major technical decisions are about to be made that will profoundly affect generations to come, [and] . . . the throne room is crowded with wizards; some [of whom] are fools and some are knaves.

"Do not let the wizards go unchallenged in front of the throne!" urges Professor Wei. "At this moment they may have more standing in court, but we know how to use the cupellation test."

— *J.M.*

Arthur P. Amesse, N.E. '67, is the Engineering Services Officer at the Naval Research Laboratory, Washington, D.C. . . . **B. James Lowe,** N.E. '58, has been appointed to the position of Vice President of Quality Control, Naval Products Division, United Nuclear Corporation . . . **Barry C. Roberts,** N.E. '63, is Commanding Officer of the U.S. Coast Guard Group, Ketchika, Alaska, and the Coast Guard Base, Ketchikin, Alaska . . . **Stuart M. Novak,** N.E. '71, is Vice President, Marine Operations, with Seatrain Lines, Inc. . . . **John Synder,** N.E. '56, worked last year with the Canadian Coast Guard on their Arctic Systems Air Cushion Transporter. He is now Chief Engineer, Global Marine Engineering . . . **Thomas L. Albee, Jr.,** S.M. '60, is the head of the Ship System Engineering and Design Department at the Naval Ship Engineering Center.

Virgil W. Rinehart, N.E. '54, has been promoted to Director of the Office of Advanced Ship Operations, Maritime Administration, U.S. Department of Commerce . . . **Richard Riley,** S.M. '46, is Manager of Profit Center Planning and Budget, Des Moines, Iowa, where he is developing the profit center concept for utility application . . . **Peter W. Wood,** N.E. '55, is Vice President of Booz, Allen and Hamilton, Inc., management consultants . . . **William Rogalski,** S.M. '70, has been appointed assistant head of the Hull Department, Washington Division of Gibbs and Cox, Inc., Arlington, Va.; he is also currently working on conceptual design of an offshore thermal energy conversion plant for the U.S. Department of Energy . . . **Spencer Reitz,** S.M. '48, has been transferred to the Electric Boat Division of General Dynamics at Groton, Conn., as Assistant General Manager . . . **David B. Flanagan,** N.E. '62, is Chief of Intelligence and Law Enforcement, First Coast Guard District, Boston.

XV
Management

David R. Peters, Ph.D. '66, is Director of the Master's Degree Program in Organizational Development at the School of Business and Management, Pepperdine University, Los Angeles, Calif. . . . **Peter Viemeister,** S.M. '69, Vice President of Grumman Corporation, has been appointed to be a director of the South Carolina Energy Research Institute . . . **Jonathan D. Casher,** S.M. '69, has founded Casher Associates, Inc., a firm specializing in data processing consulting . . . Now living in the Pacific Palisades, **Eric L. Herzog,** Ph.D. '73, is working for the Kaiser Foundation Health Plan, Inc., of Southern California . . . Following his honorable discharge from the Army, **Michael Wade,** S.M. '73, is now self-employed and living in Sun Valley, Idaho . . . **Donald L. Ravey,** S.M. '61, writes that he is "working for Memorex Corp. and active once again in ham radio (W6DBZ)."

Mark Campen, S.M. '48, has been promoted to Product Manager, Synthetic Lubricants, at Gulf Oil Chemicals Company, Petrochemicals Division, Houston, Tex . . . **David Zibbell,** S.M. '63, is Vice President of Finance and General Manager of the Superthane Division of Super Tire Engineering Company, Pennsauken, N.J. . . . **Thomas J. Vincent,** S.M. '68, has been elected President and Chief Executive Officer of Ramsey Engineering Company, St. Paul, Minn . . . **H. Russell Johnston,** S.M. '67, has joined Mansanto Corp. as a Corporate Consultant in Management Development . . . **David Tso,** S.M. '74, is now at International Crude Oil and Logistics, Gulf Oil, Pittsburgh, Penn.

XVI
Aeronautics and Astronautics

Professor **Leon Trilling** is the new Chairman of the Committee on Engineering Education, succeeding Professor **Kent F. Hansen** of the Department of Nuclear Engineering; Professor Hansen resigned when he was nominated to be a member of the Nuclear Regulatory Commission by President Carter — a nomination which the Senate refused to confirm. As Chairman of the Committee, Professor Trilling will be a principal architect of new programs for which the School seeks $10 million within the Leadership Campaign.

The Radio Technical Commission for Aeronautics has honored **Chen-Chung Hsin,** Ph.D. '76, for his outstanding work in the field of air traffic management and control by presenting him with their William E. Jackson Award — a plaque and a $1,000 honorarium . . . **Stanley G. Rosen,** S.M. '70, is Manager of Spacecraft Subsystems of the Defense Satellite Communications System Phase III, U.S. Air Force Space and Missile Systems Organization . . . **Marc Genain,** S.M. '75, is working on automatic piloting systems for subway transportation systems . . . **George M. Anderson,** S.M. '61, has joined Orincon Corp., La Jolla, Calif., as a Senior Principal Engineer . . . **Arthur V. Sedrick, Jr.,** S.M. '68, is Manager of Research for the Solar Components division of the Kalwell Corporation, Manchester, N.H.

Herman P. Schutten, S.M. '64, has been named Director of Advanced Concepts for Cutler-Hammer, Inc., Milwaukee, Wisc. . . . **Rodger K. Vance,** S.M. '67, is the Director of Facilities Engineering at Rockwell International, Pittsburgh, Penn. . . . **Alan L. Weinberger,** S.M. '61, has been promoted to Department Manager, Systems Programming, at Sperry Systems Management's Reston Engineering Center, Reston, Va.

The Air Force Systems Command's prestigious General B. A. Schriever Award has been presented to **Robert W. King,** Ph.D. '75, for his paper entitled "An Improved Value of the Earth's Gravitational Constant from Analysis of Lunar-Laser Ranging Data." The award honors the most outstanding technical achievement by a company-grade officer.

XVIII
Mathematics

After spending the Fall Term as Visiting Professor of Mathematics at M.I.T., **Felix E. Browder,** '46, who is on leave from his post as Louis Block Professor of Mathematics at the University of Chicago, is now teaching at the California Institute of Technology.

Other visiting members of the M.I.T. faculty include **Igor Dolgachev,** Associate Professor at the Moscow Institute of Electronic Engineering; **Moshe Israeli,** Ph.D. '71, Associate Professor of Computer Science at the Technion-Israel Institute of Technology, Haifa, Israel; **Louise A. Raphael,** Associate Professor of Mathematics at Clark College of Atlanta University; and **Michele F. Vergne,** formerly of the Centre Nationale de la Recherches Scientifique, Paris.

Mark J. Ablowitz, Ph.D. '71, has been promoted to full Professor at the Clarkson College of Technology . . . **Janice Rossbach,** S.M. '51, has completed 15 years with G.T.E. Sylvania as a systems engineer — and is looking forward to many more. She is currently working on Project Seafarer for the U.S. Navy.

XXI
Humanities

Nellie Yvonne McKay, Assistant Professor of English at Simmons College, is Visiting Assistant Professor, part time, in the Department this spring, teaching a course in Black Autobiography.

Saul Friedlander, Professor at the Graduate Institute of International Studies in Geneva, is Visiting Professor in the School of Humanities and Social Science this spring. He is an authority on national socialism and at M.I.T. will continue research on psychohistory — especially the relationship of myths to patterns of change in modern western society.

03

At last we have our remaining classmates, and their addresses for communication:
Ichabod F. Atwood, 279 High St., Topsfield, Mass.
Charles B. Cox, 503 Orondo Ave., Wenatchee, Wash.
William O. Eddy, 4673 Mowry Ave., Fremont, Calif.
J. Russell Jones, Highland Hills Dr., Halifax, Va.
Clarence M. Joyce, 6l9 Chia Rd., Palm Springs, Calif.
Frederick A. Olmsted, 170 Helens Lane, Mill Valley, Calif.
Andrey A. Potter, 517 Russell St., West Lafayette, Ind.

Robert A. King, one of our devoted classmates, passed away quietly on Sunday, October 31, 1977, in Courtland Gardens Convalescent Home, Stamford, Ct. He was Chairman of the King Industries, Inc. He had been a member of Salem Shepherd Lodge in Naugatuck for over 50 years, the American Chemical Society, and the Chemists Club. Mr. King was also Chairman of the Board of Piedmont College in Georgia.

Dr. King's interest in sulfuric acids led to a lifelong occupation of developing practical application of synthetic and natural rubber. Products from his research are presently sold worldwide. His career began with Merrimac Chemical Co., where he was Chief Chemist and Superintendant of Production. He worked with Thomas A. Edison from 1912 to 1915 in West Orange, N.J., and later trained as associate with George Bradshaw to establish the American Synthetic Color Co. which supplied many products to the French government during World War I.

Dr. King was born November 29, 1881, in Nashua, N.H., and resided in New Canaan, Conn. Survivors are his wife, Mrs. Levinia Knox King, a daughter, Mrs. Marjorie Louise Taylor of Darien, Conn., five grandchildren, and eight great-grandchildren. Funeral services were held at First Presbyterian Church of New Canaan. — **John J. A. Nolan**, Secretary-Treasurer, 13 Linden Ave., Somerville, Mass. 02143

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A Christmas card from **Charlie Webber** says that he was sorry not to be able to attend the reunion. He was in the midst of having an operation at the time. I expect to hear more from him about this. . . . **Harold Mitchell** has had a pacemaker installed. Both he and Mildred are getting along fine. They have been having a hard winter so far. . . . **Rock Comstock** has a question. He has previously caught two field mice during a winter. So far this winter (six weeks) he has caught 16. What does this portend?

We really have some gadabouts in our midst. **Wally Murray** is one of them. He writes at length about his recent trip to the Northwest. This time he covered Salt Lake City, the Kennecott open-pit copper mine, a Salt Lake marina, where all the boats are sail because of the corrosiveness of the salt water. He also visited the State House at Salt Lake City, the University, the Morman Temple and Tabernacle, and took a cable car up the Wasach Mountains. He stopped at Logan and Montpelier, Jackson Lake, and the Grand Tetons. Can you imagine Wally in a rubber boat going down the Snake River? He did it. How old are you anyway Wally? He also visited Yellowstone, Cody, Wyo., Deadwood, S.D., and panned for gold near the Homestake Gold Mine without any luck, and on the way home stopped in the Big Horn Mountains and at Mt. Rushmore. All this in about ten days.

Jonny Noyes, another of our traveling members, has recently returned from an island-hopping trip to the Philipines. He now expects to spend a "few weeks loafing" in Mexico and will attend the M.I.T. Fiesta there. This will be his eighth year attending the Fiesta. Jonny thinks more 1912 members should attend. Jon, we'll expect a good story for the *Review* covering all your doings.

I would appreciate any information you may have on the following, as my cards have been returned: **Jos Champagne**; **Harold Mabbott**; and **Horace Payson**. — **Larry Cummings**, Secretary, R.R. 4, Connersville, Ind. 47331

14

Hibbard S. Busby died on December 16, 1977, at the age of 85, in a hospital near his home in LaGrange, Tex., after a ten-day illness. He was a Course XIII man and entered the Institute from Chelsea. After service in World War I, he was a research colorist for some years with Cheney Brothers in Manchester, Conn., and later a consulting colorist in New York City. In 1927 he became head of the Textile School of Georgia Institute of Technology in Atlanta, and later was Educational Advisor of the Fourth Corps Area in that city. During and for a few years after World War II, he was Inspector of Naval Materiel in Atlanta, Dallas and New Orleans. Later, Bus taught industrial engineering, first at the University of Hartford (Conn.) and then at Western New England in Springfield. After his retirement he lived in Brevard, N.C., for a few years, and for the past seven years in LaGrange, where he could often see his children and their families. Bus is survived by his wife, the former Edith D. Dimick; two daughters, Mrs. Gloria Helmer and Mrs. A.J. (Mary Jane) Schribner, both of Dallas; a son, Dr. Roy K. Busby, of Denton, Tex., and four grandchildren.

A note from his wife in November told that **Louis B. Black** had died in 1976. His career was with several manufacturers of machinery in Toronto, where he had lived since 1919. — **Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Conn. 06119

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This is the day of the famous blizzard here — stopping everything and everybody! I hope those "snow birds" led by **Jim Tobey** and **Wayne Bradley** are luxuriating in the sunshine of Florida. Maybe more of you have luckily followed them into the land of sunshine.

Mary Plummer Rice has been staying home for a change from her activities with several worthwhile projects. . . . **Phil Alger** miraculously recovered from his recent serious illness, sent his usual Chirstmas poem and an announcement of his recently published book, *More Tales of My Life and Family* — truly a remarkable fellow! . . . **Bill Brackett** reports the usual amount of ailments that go with age 85. He writes he gets up at 6:00 a.m. and is glad he can get up. His son, Dick, M.I.T. '47, drove him up to see me and it was remarkable to see how expertly Bill hobbles around on two crutches. . . . **Jerry Coldwell** does not go out much but can keep busy at home — good for him! . . . **Alton Cook** passed up a New Year's party with the feeling that at our age we must first take good care of our health regardless of all tainment offered us. How he has slowed down! . . . **Henry Daley** was in the hospital in the summer but is home now feeling better. Keep it up, Henry! . . . **George Easter** was in Florida at Christmas. His daughter is Director of Nursing for the Seminole County Board of Health. . . . **Ray Gladding** sent me a "get well" with the news that he is "taking it easy" in his retirement. . . . **Otto Hilbert** keeps busy writing the historical record of Corning Glass Co. He says there are many M.I.T. men in Corning and they have nice get-togethers at lunch.

Wally Pike had a slight heart arrest and was in the Mt. Auburn Hospital, Cambridge. He's been home some time now feeling better but a little impatient with his enforced bland salt-free diet. . . . **Bob Welles** keeps going remarkable well. From Yosemite Park he wrote, "I am spending Christmas here with my two daughters and a granddaughter. Two of them went skiing today — which is beyond me! There are 40 inches of snow on the ski slopes, but it is raining now, even on the slopes at 8,000 ft." That sounds too rugged for the rest of us.

Here's a good letter from **Evers Burtner**. "I have heard that you are much better than you were. Fine! One is very lucky to have minor ailments after reaching four-score. Here in Ft. Myers I see a few oldsters who make me envious; however many look like they had problems.

"I had expected to turn towards home by February but may stay a few days longer. Had a three-day stop at Ft. Myers last year when my son James and family made a flying trip. This city downtown has much to offer. A five-minute walk reaches several good restaurants, the tourist center, library, post office, and Yacht Harbor.

"I had a brief note recently from **Ellis Ellicott**, who likewise is a widower. Recently I published a little booklet dealing with Open Class Yacht Rac-

ing at Marblehead that many friends have liked. With my best to you for 1978!"

To answer many of you kind and thoughtful fellows, I am improving steadily and soon may be able to walk alone without a cane. It is taking a little longer to resume writing.

Dr. **Stanley M. Baxter** died recently. We have no details. **Everett R. Brigham** died November 7, 1977 in Ormond Beach, Fla. The sympathy of our Class goes to their families. All the best! — **Azel Mack**, Secretary, Apt. 214 C, 100 Memorial Dr., Cambridge, Mass. 02139

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Evidently the severe winter had an adverse effect on our correspondence. Letters have been scarce in the last couple of months. Fortunately, we have had a few telephone contacts. Talked with Hildegard and **Jap Carr** and they are well. They were, as usual, enjoying the Palm Beach, Fla., area during the cold half of the year. . . . **Barney Gordon** decided not to go south this winter and remained in the Boston area for the winter. . . . **Francis Stern** called from Palm Springs, Calif., and alerted us to **Walt Binger**'s 90th birthday celebrated at the monthly '16 and '17 luncheon meeting at the Chemists Club in New York City. Francis prepared this brief tribute which was sent to Walt on his birthday, January 16: "Over the years, the Class of 1916 has filled its treasury, not with gold, but with far more precious things — mutual respect, understanding, affection, accomplishment and some bit of wisdom. In all these possessions, no one has contributed more generously than you." . . . Thanks, Francis, and thanks, Dick Loengard of '17 for keeping us posted and for making a special effort to get '16ers to the luncheon. Generally **Charlie McCarthy** and **Rudi Gruber** attend these luncheons, and **Francis Stern**, when he is back in Hartford.

Very pleased to receive Christmas cards from Mertie and **Allen Giles**, Silvia and **Vert Young**, and from Ruth and **George Maverick** who wrote: "We have had a good year, highlighted by a reunion here (Charlottesville, Va.) of our two daughters, nine grandchildren and 12 great-grandchildren, plus spouses, for our 60th wedding anniversary. It was wonderful but kept us from the Class Reunion."

Speaking of class reunions, our 62nd will be held on June 6 to 8, 1978, at Chatham Bars Inn. In late January we had a pleasant call from **Paul Duff** to get the reunion dates and to tell us that he and Frances are well and will attend.

We're sorry to report that **Charlie Crosier**'s wife, Marian, passed away last year. He wrote: "My outside activities include participation in church groups, A.A.R.P. and a local conservation trust." . . . May we close with the happy note that it's great that Azel Mack is back in harness for '15. He has always set a high standard for all of us to follow.

Keep the cards, letters and calls coming. We welcome all communications as material for this column. Remember the advice of **Cy Guething** —"Keep breathing!" — **Ralph A. Fletcher**, Acting Secretary, P.O. Box 71, West Chelmsford, Mass. 01863

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We have a new Aldrin Scholarship Fund Scholar, David Alexander, '80. He is a sophomore in aeronautics and astronautics and hails from Salem, Ore. Further information about him will appear later. There have now been four Aldrin Scholars, and aid to a fifth student: Owen Knox, '76, the first Scholar, is back at M.I.T., as a graduate student in Civil Engineering; Michael Solis, '77, is completing his thesis to graduate next June, after an interruption; Paul LaGace, '78, is a senior with a cumulative grade point average of 4.8 out of a possible 5.0; Alan Giombiki, '77, was the fifth student to receive Fund aid and is now in medical school. The income from the Fund for current use is $5,541. This is shared about equally by Solis, LaGace and Alexander. The Student Financial Aid office expresses its gratitude for this Fund income, aiding these students who likely would not be at M.I.T. were such aid not available.

It will be recalled that our 25-year Fund was available for student aid, preferably to a descendant of a member of the Class. The entire sum, about $3,000, was loaned in 1967 to Chi Kuan Wu, grandson of **P.Y. Hu**. Chi earned his B.S. and M.S. degrees and is now employed by G.E.

We are sorry to report that **Chet Ames** was prevented from attending our 60th reunion because he suffered a mild stroke at that time. He is now recovered and is able to drive his car and get about pretty well. He intends to come to our next reunion if it is held not too far away from his home in Winthrop.

Dick Loengard reports that he and **Bill Neuberg** were the only attendants from 1917 at the New York December luncheon. Walter Binger and Rudy Gruber represented 1916. Dick says Walt is remarkable in that at age 90 he still rides with the Fairfield Hunt Club and is proud of the fact that at their recent hunt he didn't miss a single jump.

Marion and **Les Ford** are going to Florida for March and April. They will be at the "Bahia Vista" in Venice. . . . Helen and **Stan Lane** are also spending January, February, and March, in Florida at the "Starlite Condominium" in Boca Raton. . . . **Connie Coakley** sent a note from Richmond, Va. He says he had three Christmases; two in Richmond and one in Rockingham, S.C. He still remarks on the enjoyable time at our 60th reunion, and that the bad weather at Chatham Bars "helped confine the gang" and made for a better than usual get together. . . . **George Henderson** reports that he recently suffered some illness, but plans to spend February in San Diego with his son, who like George is a retired Naval officer. . . . **Cy Medding** and his wife, Elizabeth, are spending a month in San Antonio.

Helen and **Stan Lee** left for Boca Raton, Fla., right after Christmas. In February Helen was stricken by a cerebral hemorrhage and died on the 15th. A service was held for her on February 20th at the Wellesley Baptist Church which was attended by **Al Lunn**, **Ray Stevens**, Edna and **Brick Dunham**, Phyl and **Don Severance**, Jeanette and **Stan Dunning**, and Doris and **Bill Hunter**. Helen was a regular attendant at our reunions, and her presence will be sorely missed. The sympathy of all of us is extended to Stan. Helen is survived by her husband, two daughters, 12 grandchildren, and 17 great grandchildren.

A note from Olive and **A.P. Sullivan** remarks on the happy time all seemed to have at the 60th reunion. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

18

I write these notes on February 6 in Brookline while the weather forecasters are assuring us the worst (or best) winter storm ever to hit Boston is howling outside. I can believe them — and envy so many of you who have taken refuge in the South and Southwest of our country. I am very happy now to share with you at this late date the season's greetings which arrived too late to be included in last month's *Review*.

From Monterrey, Mexico, is a note from **Roberto Garza Sada**, who responds to our letter of invitation to celebrate our 60th anniversary in M.I.T. "I certainly will do my best to be with you on this celebration." he writes.

A note from **A. B. Vought**: "I have always remembered Tech, the things it stands for, and the help it has been to me over the years. I have tried to acknowledge this, in a small way, by regular contributions to the Alumni Fund, especially in my later years. I must tell you that I will not be able to come to the reunion, but I will be there in spirit."

Jim Flint writes: "As usual, I'll be on my way to New Zealand and Australia in two or three weeks — I go down there to fish and visit old friends. I really have no plans to go East — even as you point out it will be 60 years! I much prefer to skip birthdays and reunions — they do nothing for my morale."

Season's greetings were also received from the **Bill Fosters**, the **Sumner Wileys**, **Arthur Williams**, the **Pete Harralls**, **Charles Dimock**, **Ted Braaten**, **John Kiley**, the **Charlie Watts**, **Edgar Goldstine**, **Bertram Jones**, and the **John Abrams**.

I note with sadness the passing in July, 1977, of **Carl McLaughlin** as reported by his daughter, Mary: "He suffered a severe heart attack last January from which he was unable to recover. Prior to his heart attack he was in excellent physical and mental health and led a vey active life for his age." — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass., 02146; **Leonard Levine**, Assistant Secretary, 599 Washington St., Brookline, Mass. 02146

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Don Way reports the passing of **Herbert W. Best** in Palma de Mallorca, Spain, on September 28, 1977.

Christmas messages came from many of our class. The following excerpts come from a letter (a recording) from **Robert Burns MacMullin**, Lewiston, N.Y.: "Olive had the cataract on the other eye removed, in April. Now the birds at the feeder, and the cross-word puzzles, are back in focus. Creaky bones and protesting muscles notwithstanding, we're both in good health. . . . R.B.M.A. has moved to new offices at 826 Pine Ave., Niagara Falls, N.Y. 14301. It took us a month to get ready, two days to move and a fortnight to settle down. Our new quarters are most attractive. This year we did a job for Diamond/Shamrock, on ways to convert cell caustic to soda ash, something I worked hard at 20 years ago. It was a bit more work for me than I had bargained for. When the report went out, just under the deadline, I felt as though I'd been through the wringer. Retired? no, just tired. . . . The Geology Club continues to be an absorbing diversion. Bob arranged for a second printing of the Walker's Guide to the Niagara Gorge. Some 3,000 people, including lots of school children, have taken the guided tours this year, and the State has provided the guides. We've put on two exhibits at Rock and Mineral shows, made field trips, and given lectures on impact craters, volcanos and spelunking. We had a few whirlpool reversals in April — then came the rains. There's been too much water out of the upper Lake for any more reversals until early next year. . . . Some folks worry about the times: money, morals, environment, health. We don't. Too busy."

A nice card arrived from **Jim Reis** of Los Angeles with best wishes for the class. . . . A note from **Ralph H. Gilbert** of Point Lookout, N.Y., says: "I keep busy living here alone with my dog since I became a widower in 1972. Since then I have attended our reunion in 1974 and taken two trips to Europe in 1974 and 1975. Now I'm looking forward to our 60th in 1979."

Roy Burbank sent holiday greetings and is looking forward to spring. He and Margaret had a very rewarding vegetable and flower garden in 1977. . . . Iva and **Ev Doten** wrote at Christmas: "We've got our calendar marked for June, 1979. This year has not been one of our best but we are looking for 1978 to be much better."

John Stevens visited with me in early January. He has been in good health and is in Florida for the winter. He expects to make our 60th in 1979 and is looking forward to it. . . . **Nelson Bond** has just arrived here and is staying at the Colony Hotel on Atlantic Ave. in Delray Beach, Fla. — **E. R. Smoley**, Secretary, 50 East Rd., Delray Beach, Fla. 33444

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Those two grand old "salts," **Hank Caldwell** and **Heinie Haskell**, have lost none of their sailing skills as evidenced by Hank's remarks about the problem of whether a double jib rig (two masts and two stays fore and aft) is appreciably more effective than the regular jib and main which offers the same total sail surface. Hank signs himself " a really ancient mariner." Heinie reports that he and Hank got together last year while his

boat, the *Emily Morgan*, was being built; later, Heinie sailed his new boat from South Carolina to New England last summer — quite a feat for an 80-year-old. Heinie says he can still manage some single handling and adds that he didn't meet any M.I.T. crews en route. Where were *you*, Tony and Buzz and Dick?

Others mentioning the 80th milestone are **Dolly Gray** of 4425 Coco Ridge Circle, Sarasota, who also proudly states that his marriage has lasted for 56 years, and **Herman Marrow**, also from Sarasota, who achieved the 80-years status last December.

A welcome note from **George Des Marais** to say that he enjoys leisure time for billiards, swimming, and a fine flower garden. He attends a monthly meeting of eleven M.I.T. men at Rossinoor, N. J., for a luncheon get-together. George is able to boast of two grandsons that have graduated from college and two more (one a granddaughter) in college. **Harold Bibber** writes that last summer he enjoyed the fine days of the first Alumni College of M.I.T., although he did not find other classmates there. He says, "The West Campus still amazes me." Harold spends most of the winter in Sanibel, Fla.

It was gratifying to note that **Buck Clark** has been given the American School for the Deaf's Award of Merit for distinguished service. Myron has served on the School's Board of Directors for 35 years. Last Christmas he and Mary entertained no less than ten grandchildren. With most of us having widely separated children and grandchildren, we deem the Clarks to be exceedingly fortunate.

It is with regret that I observe the passing of one more fine classmate, **Bill Honiss**, of 272 Key Palm Road, Boca Raton, Fla., on November 21. Bill was long a resident of Hartford, an executive of Embart Corp. there. He will be missed by us all.

The *Wellesley Townsman* contains an interesting item about **Al Wason**: "A retired U. S. Army officer, Colonel Alred Wason of Kenilworth Circle was honored for his 55 years of loyal and dedicated service to the national security and the Reserve Officers Association by induction into R. O. A.'s Longtimer Club. The citation was given by Major General Milnor Roberts, National Director of R. O. A. in Washington. Col. Wason, a retired Westinghouse executive in civilian life, joined the Reserve Officers Association a few weeks after it was chartered by Congress 56 years ago. Col. Wason served in World Wars I and II and as a Quartermaster Corps officer in the post-war period." — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Betty and I wish to thank those that sent us holiday greetings, which included: Marion (Mrs. **George**) **Chutter**, Maxine and **Cac Clarke**, Claudia and **Josh Crosby**, Velma (Mrs. **Sanford**) **Hill**, Betty (Mrs. **Dugald**) **Jackson**, Ruth and **Irv Jakobson**, Emma and **Al Lloyd**, Elma and **John Mattson**, Helen and **Bob Miller**, Marianne and **Grant Miner**, Helga and **Jim Parsons**, Betty (Mrs. **Norman**) **Patton**, Kay and **Larc Randall**, Graciela and **Helier Rodriguez**, Anne and **George Schnitzler**, Beth and **Whit Spaulding**, Dorothy (Mrs. **Joseph**) **Wenick**, Hazel and **Whit Wetherell**, and Ruth and **Ralph Wetsten**.

In a phone call to Ceil and **Frank Huggins** at their plantation house in Frogmore, S.C., we learned that Frank had a fall last March which took him into the hospital with a dislocated shoulder. He was there and in a nursing home for two to three months and is now confined to his home. He'd like to hear from his friends.

Alumni Fund envelopes brought news from five classmates. **John Sherman** writes, "Spent the best part of the year recovering from surgery on both of my knees. Now I have new prosthetic joints in both legs — wonderful to be rid of the pain and deformity resulting from years of arthritis. I'm still part-time Curator of the Museum at the Masonic Temple in Boston." . . . **Al Genaske** reported, "I'm temporarily grounded because of a cataract operation last October but still planning to go to Florida in January." . . . **Elizabeth Shepard** wrote, "Life remains too busy, but interesting and fun. We travel a great deal, and I am active in the Agency on Aging, two hospital auxiliaries, and the League of Women Voters." . . . **Elmer Campbell** was elected Commander of the St. Petersburg chapter of the Military Order of the World Wars. Accompanied by his wife Becky, he attended the National Convention in Los Angeles last August and then went on to Hawaii for a two-week tour of the four major islands. They saw the smoking fumeroles at Kilanea Crater about two weeks before it erupted. . . . **Horace Tuttle** reported, "Nothing new. I'm still in the same group of Bloomfield, Conn., 'music makers' — a small group of senior citizens that sing, play instruments, dance, and do special acts for convalescent homes, insurance company groups, etc. There are 40 of us with an average age of 75 years."

A Course XII questionnaire to **James Cudworth**, Dean Emeritus of the College of Engineering at the University of Alabama, reported the following honors since 1972: Erskine Ramsey Gold Medal, A.I.M.E., 1972; Life Member A.S.E.E.; Capstone Engineering Society, 1976; Engineering Building at University of Alabama, Birmingham, named Cudworth Hall, 1977. Congratulations, Jim! — **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

We are grateful to our M.I.T. friends and classmates for Christmas Greetings and most thoughtful best wishes for the New Year.

President Wiesner has forwarded the desk arm with bronze plate from Room 10-250. We enjoyed the good picture of remodeled Huntington Hall.

Edna and **Bill Mueser** enjoyed their large family gathering at home at Christmas. . . . Madeline and **Parke Appel** insist that we see them in January or February in Venice — and we shall. And the same goes for Carlys and **Frank Kurtz** in Delray. . . . Catharine and **Mac McCurdy**'s picture of *Blue Peter* sailing on the Sound made us want to return to their beautiful situation in Seattle.

Stan Dunning, '17, has forwarded a clipping reporting our loss in January of **William W. Russell**. Services were held in the Old South Church. Bill was one of our great classmates who met with us many times in the old Statler days. He was a prominent real estate executive and churchman, an avid curler and golfer. He was a member of professional groups, the Canadian Club of Boston, and the Brae Burn Country Club of Newton. We mourn his loss.

Again we ask all classmates to please send news. — **Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

The *Christian Herald* of December, 1977, published an illuminating article by **Albert J. Pyle** entitled "The Lower Lights," giving a colorful description of the wreck of the steamer *Winslow* which stood out from Cleveland on October 7, 1864. The sinking of this ship in Lake Erie while approaching a dock in a storm inspired evangelist Dwight L. Moody in May, 1871 to preach on the theme that man must maintain lower lights, while God keeps higher light. This sermon prompted Philip P. Bliss to write the famous hymn, which ends, "Let the lower lights be burning, Send a gleam across the wave! Some poor fainting, struggling seaman you may rescue, you may save."

Royal Sterling, Chairman of our 55th Reunion this June, reports that as the date approaches, requests for reservations are increasing. It appears that more than 100 of us will attend our Reunion in Cambridge and on the Cape. **Alan R. Allen** is planning a non-stop picture show including informal shots of all class gatherings since our Senior Picnic in 1923. This activity will not interfere with other scheduled events.

Lewis J. Powers reports that he is retired, living in Springfield, Mass., and enjoying his two grandchildren, L. J. Powers V and Samuel Bryant Powers. . . . **Philip S. Wilder** reports that his son, Philip S. Wilder, Jr., a graduate of Bowdoin College and a former Brunswick resident, was named President of Hartwick College on September 7, 1977. . . . **Hugh D. Chase** of Quincy, Mass., tells us that he spent an enjoyable month last fall visiting old friends and acquaintances.

Paul A. Blackwell passed away on October 11, 1975. During his undergraduate years he was Treasurer of the Electrical Engineering Society, on the Finance Committee of the Combined Professional Societies, and a member of Theta Tau, Hexalpha, Vectors and Alpha Tau Omega. He was a Sales Engineer for the General Electric Co.

Hugh H. Spencer died on December 10, 1977, at his home in Villanova, Penn. He was an employee of RCA for more than 30 years. After his retirement in 1966, he taught General Science at St. Joseph's College in Philadelphia. He was a member of the American Society of Mechanical Engineers, the Institute of Radio Engineers, and the Franklin Institute; and a Life Member of the American Institute of Electrical Engineers. — **James A. Pennypacker**, Assistant Secretary, Long Hill Road, Essex, Conn. 06426

24

My sincere thanks to all for your kind cards and letters of sympathy. It is comforting to know that so many care.

From Fund envelopes and letters: Edith and **George Knight** are spending their annual sojourn in England. . . . Anne and **George Tapley** (Florida): "We had a quiet year with golf, bridge and a few parties down here — two months in Winnipasaukee, but arrived North too late for the mini-reunion, a disappointment to me." . . . Grace and **Mark Sinnicks** (Santa Rosa, Calif.): "Moved here to Varicose Valley that is fairly level after Grace had open heart surgery. She's recovering nicely after two months' hospitalization at Stanford. The drought dried the springs at our summer place where it was over 100°F. regularly."

Rut Torres-Saravia (Mexico): "May consider myself lucky. Had a cancerous tumor extirpated from my left vocal cord last July. At present have recovered my voice and am feeling fine. No post treatment." . . . **Dave Kanter** (New York): "A grandson, Michael J. Fink, is a member of this year's Freshman Class. My dream of many years has come to fruition." . . . **Bob Morton** (Florida): "Still playing golf and fishing but my eyes are giving me trouble. We may move back to St. Louis next year where my son is still living."

John Walthall (Alabama): "Activities the past year included redecorating the house, cruising the Tennessee River, ham radioing and an auto trip to Mobile for the annual meeting of the National Trust for Historic Preservation and another to the Chesapeake Bay region visiting boating friends." . . . **Dick Lassiter** (New Jersey): "Just had a week in coronary care at the hospital (angina pectoris). Better now, I think."

Sam Helfman (Louisiana): "I am semi-retired; have my own consulting-engineering practice. My clients are consulting engineers who need help in the preparation of economic-feasibility reports on electric and gas utilities, particularly coal-synthesis gas electric generating plants. Principal hobby is golf, but I am a hacker. My wife and I just returned from Hawaii, where I developed a crick in my neck from watching the hula dancers." . . . **Ray Lehrer** (Boston): "Having reached the age of 75, of which 45 were spent in the insurance business, I find that it is time for me to retire."

The Florida Fiesta in January was a great success. The weather cooperated, even awaiting the end of festivities before the big blow and rainstorm. Present were: Helen and **Dick Shea**,

Allora and **Clint Conway**, Besse and **Phil Blanchard**, Mary and **John Fitch**, Clare and **Gordon Harvey**, Bubbles and **Andy Kellogg**, Kitty and **Frank Manley**, Ettie and **Gene Quirin**, Marion and **Henry Rau**, Eva and **Jack Walthall**, **Gordon Billard** and **Ed Moll**. A delicious dinner Tuesday night at the Limetree Inn in Lido Beach, Sarasota, was followed the next morning by a two-hour boat ride around the harbor, admiring the luxurious homes and yachts. The climax was dinner at the Golden Apple with the inimitable Molly Picon starring in the delightful "Second Time Around." **Ed Moll**, 55th Reunion chairman, presented a preview of some thoughts on the agenda. All in all, it was a pleasurable mini-reunion, non-cooled by thoughts of our mates in the frigid, snowy North. — **Russell W. Ambach**, Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

26

It has been a wild winter U.S.A. The Pigeon Cove variety has involved 55 m.p.h. winds hour after hour gusting to 60 and above with the wildest seas one could imagine, and snowing all the while. The one thing that saved the day (and the night) was that the usual power failure did not occur. However, we are writing on January 31, so it's a long haul yet.

One thing not experienced inland is the beauty of the sea after the storm. We can have drifts seven feet high in our driveway and iced ruts five inches deep but all this disappears as we look out at the ocean. Its moods, colors, sparkle and action are indestructible and do not tarnish or soil. The salt coating on the glass doors got pretty dense but a freak 50° day allowed us to wash them (and the Volvo) and continue enjoying the view.

Tonight is Alumni Council in Cambridge but better for putting together Class Notes than driving the 80 miles round trip with an aching back. So we remembered that there was some backache medicine in the closet that **Bruce Powers** brought to our 50th reunion and a couple of tablespoons of it seem quite effective.

We have some of the messages you wrote on the back of Alumni Fund envelopes that will comprise this issue of notes. **Juan Chaudruc** (postmark Asheville, N.C.) says: "Rebuilding old homestead of unknown vintage but having tough hickory and oak timbers. Then, for relaxation, Janet joins in hiking the trails of the Blue Ridge Mountains in Pisqah Forest. Still singing first tenor in choir at Saint John in the Wilderness Church at Flat Rock. Expecting **Winslow Russell** to drop by on his way to **Newt Roberts** in Fernandina Beach, Fla."

The next one from **Roger Macdonald** (you may remember him as Irving) bears a P. O. of Woodstock, Conn.: "Sally and I thrive, enjoy our year round Connecticut home and visits from all family. Grandson Steve Horton, U.S.N., made Lt. (J.G.), qualified for dolphins, and won Hobie-14 Regattas from L. I. Sound North while stationed at Portsmounth, N. S. Granddaughter Connie Paige presented second great-granddaughter Jennifer, joining Christine; her husband Richard won promotion in D & B — Roger."

We have mentioned previously the establishment of a swimming club locally in a delightful indoor pool. A year ago we could just about make ten yards without collapsing but someone reported that it was good for strengthening the back so we are now up to 500 yards daily — yes, we *are* bragging but next summer when we try the cold ocean, hopefully the ten-yard figure will be possible. Before you start throwing snowballs — cheerio until May. — **George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

27

Ted Ordman finally decided to retire, as of the end of 1977, after 40 years with the same New York patent law firm. A year ago, he told me that whenever he did retire, he and Valda would plan to spend winters in Montego Bay, Jamaica, where Valda owns a home, and summers in Dutchess County, N.Y., where they have a summer house. . . . **John Crawford** writes that last fall, he and Lane went off on their first "scheduled" vacation trip (instead of just throwing baggage into the car and taking off). They went by C. P. Rail, ferries, rented car, and air to Victoria, Seattle, San Francisco, Fargo, and home to Long Island.

It is good to hear from **Joe Harris** that his condition is "stable." . . . **Dick Cutts** says only that he is enjoying his tenth year of retirement, and **LeRoy Miller** that the 50th Reunion was "a great adventure and joy". . . . **Al Buffum** is still very active in civic affairs in Elkhart. The list includes Advisory Council, Elkhart Career Center; Elkhart Conference Development Center; and Chamber of Commerce Planning Committee. In addition to local golfing and two months at Apopka, Fla., he finds time for a lot of fishing in Alaska, Canada, and elsewhere. This year's plans include arctic char fishing in Northern Baffin Land, in the Canadian Northwest Territory. He will be living in an eskimo camp.

Art Buckley continues to teach part-time — math and science — in the high schools of Washington County, Md. . . . **Jim Lyles** keeps busy with genealogy and historical societies. . . . **Walter Walker**, who had planned to attend the Reunion, writes, "I was sorry to miss it, but I produced a kidney stone, and such items are nonnegotiable."

For those who may be traveling south of the border, **Dwight Moore** reports, "Recently played Bajamar Country Club along Pacific Ocean, 20 miles north of Ensenada, Mexico. Greens superb, fairways excellent, rolling, narrow, with sagebrush for rough. Tees separated from fairways by up to 180 yards of sagebrush which must be negotiated on your drive. Recommend a dozen extra clunkers for those who don't hit long."

Here are a few more "missing" classmates. If anyone knows where they can be reached, please notify me or the Alumni Office:

Capt. **John J. Johnson**, **I. Chi Ko**, **Richard J. Koch**, **Kinji Koyama**, **Rosemary N. Kutak**, **Tse C. Lee**, **Frank C. Lin**, and **Randolph E. Many**.

Your secretary has completed his stint with United Way and, except for two weeks of jury duty in January, has again become an idler. — **Joseph H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

28

The final mailing relative to our 50th Reunion will have gone out to you by the time you are reading these notes. Those classmates who have expressed interest in attending should now have received a final registration form. If you have not yet sent in your registration and deposit, please do so now. Those who may still want to attend, after making a late decision, should let us know just as quickly as possible. We expect close to a full house at McCormick Hall, and late room assignments could become a problem. Local hotels will also be full.

In a letter from **Herman Daiker** we learn that he started out in the landscape business in 1930. By 1936 he had built seven greenhouses and opened a flower shop in Bridgewater, Mass. The greenhouses were sold in 1963, but Herman and wife Madeline continued to run the flower shop until three years ago. Now they are retired and daughter Carol and her husband run the shop. Herman is a past president of F. T. D., Region I, which includes Boston. The Daikers have their summer home in Cataumet on Cape Cod.

It is always a special pleasure to hear from our class widows. Iris (Mrs. **Ermanno**) **Basilio** told of her pleasure when acting as representative of her alma mater at the inaugural convocation of Cornell University's new president. She was also pleased to report that her son was having his first book published. . . . Frances (Mrs. **Carl**) **Myers** has done a great deal of traveling. One trip took her to Rome for a 45-day visit with her younger son and his family. Last year she attended the 50th reunion of her Simmons College class. It was an occasion that far exceeded her expectations. . . . Mary (Mrs. **Arthur**) **Nichols** has been spending the winter in Florida but expects to be back in plenty of time for our reunion. . . . Ethel (Mrs. **Carl**) **Bernhardt** remembers out 45th with much pleasure and, although having done little traveling since then, does look forward to being with us for the 50th.

Dempe Dempewolff reports that he has come across some old '28 mementos and wonders if they might be of interest in connection with our reunion in June. The answer is a most emphatic "yes." Our program will include a social gathering at the M.I.T. Historical Collections where a special exhibit will be set up featuring items relating to the history of our class. By all means, send in or bring along any or all items for this exhibit. Where appropriate, some might be donated as a permanent part of the Historical Collections. — **Walter J. Smith**, Secretary, 37 Dix St., Winchester, Mass. 01890

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James B. Magenis writes: "I am enjoying my retirement immensely! If I don't feel like doing something today, I know that I will have time to do it tomorrow — no pressure at all. Activities include: baby-sitting for my grandchildren, walking for exercise, travel, and visiting grandchildren. I am enjoying generally good health, except for a little high blood pressure and cataracts."

Steve Dilworth and wife Myn, whose romance and courtship during our 45th Reunion culminated in marriage, are vacationing in South Florida this winter. . . . Our Mini-Reunion at Billings, Montana, last September is still making waves and ripples. **Wally Gale** attended, and writes: "The Billings extravaganza was enlivened and enrichened by the presence of **Gus Stein**, who flew in from Boca Raton, and **John McCaskey** and his wife Marian, who interrupted their doctoral studies at the University of Montana and drove down from Missoula. **Bill Aldrich** with his wife Maxine were our host and hostess, assisted by the Aldrich family — the same group of professional entertainers who added so much to our rain-soaked 30th Reunion at Bald Peak. Activities included a festive banquet at the country club, two days of fishing on and near Rose Bud Lake, high in the Rockies, and an old-fashioned cook-out featuring Montana beef and hospitality. The purpose of the San Francisco dinner was to meet with local classmates and, by mutual interaction (86 proof), to build up steam for our forthcoming 50th Reunion and Class Gift. The arrangements were strictly soigne, thanks to the efforts of **George Burgess** and the catering staff of the Clift Hotel. **Dick Piez** was co-host. Those who drove many miles to attend included Gene and **Ted Alexieff**, Myrtle and **Bob Haskell**, Kay and **John Howell**, and Dorothy and **Wade Shorter**. It was a very pleasant occasion, and we hope a rewarding one."

Dave Wilson continues his active participation in the manufacture of brassieres (Golden Bra Co.), located in a building owned by M.I.T. on Albany St. His oldest son has joined him, which must have taken most of the business pressures off Dave. His wife, Ethel, is very active doing volunteer work and serving as member-at-large for the National Women's Committee of United Cerebral Palsy. One of their grandsons just graduated from M.I.T. And one son is a vice president of Drexel-Lambert (finance) in New York City. A third son is an anaesthesiologist at Maine Medical Center in Portland. Dave has just turned 70 but he says he feels like 39.

There were two errors in the notes for December. **John Rich**'s wife's name was misprinted Aline instead of Olive, which might have given the false impression that John has a new wife. Olive is quite well and they are very happily married. I also reported that **Bill Baumrucker** purchased a Mercedes-Benz in Germany, and after driving all over the Continent (with the John Rich's) shipped his car to the States duty-free; it should have been stated as reduced tariff. — **Karnig S.**

Dinjian, Secretary, 6000 N. Ocean Blvd., Apt. 14E, Fort Lauderdale, Fla. 33308; (305) 946-0425

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We seldom have news of our overseas classmates, but this month we have heard from **Alfredo Gutierrez**, formerly of Mexico City, who has selected Garmisch-Partenkirchen, Germany, as his retirement home. Alfredo is currently trying to organize an M.I.T. Club in Germany. It appears that Alfredo was for many years a member of the very active M.I.T. Club of Mexico City, and having been conditioned to the annual fiesta of the Mexico City Club, which is attended by many U.S. alumni, he decided that it would be a good idea to organize a club in Germany with possibly an annual get-together during the skiing season. Alfredo mentioned that he has available a completely furnished vacation apartment (Ferien-Wohnung), capable of housing two to five people and renting at a modest daily rate. If you are interested you can write him at Am Muhlbach 14, 81 Garmisch-Partenkirchen, Germany. Alfredo and his wife have two sons, the younger of whom at 8 years old may well be the youngest child of the class of '30. Are there any other contenders? Needless to say, Alfredo is an enthusiastic skier and at the time of writing was looking forward to the World Ski Championship scheduled to take place at Garmisch in late January and early February. He also lists a hobby that may be familiar to some of you but which is new to me, namely, "wind-surfing."

John Hanley retired as Vice President of Northern Natural Gas Co. in 1973 and still lives in Omaha. His hobbies include trout fishing, duck hunting, and golf. The Hanleys have a son who is an paleontologist and two grandchildren. As previously reported, the Hanleys and the **George Lawsons** spent a joint vacation at Jackson Hole, Wyo., several years ago. . . . **Bill Griffith** is a retired consulting engineer who lives in Tucson, Ariz. He has returned to school, to the Graduate School of Computer Science at the University of Arizona. Bill lists his hobbies as boating, scuba diving, fishing and golf. . . . **Bill Harris** retired some years ago. His home base is Wellesley Hills, Mass., but he moves about quite a bit during the course of a year, spending July in Maine, August on the Cape, part of September in New Hampshire, and part of April or March in Florida, in addition to interspersed overseas travel. He lists among his hobbies the design of medical devices, especially for diabetic patients.

Win Hartford is one of our more active classmates. In recent years he has been teaching chemistry at Belmont Abbey College in Belmont, N.C., but since last fall has been working full time on environmental science: teaching at Belmont Abbey; working with local organizations and political leaders; and speaking and writing on this subject. He has recently completed two chapters for encyclopedias, one on chromium chemicals for the Third Edition of *Kirk-Othmer* and the other on applied electrochemistry of chromium for "Electrochemistry of the Elements." He is also still consulting for the wood-preserving industry. His environmental pitch holds that, "Good old chemical thermodynamics is the primary consideration, and we must attack *causes* rather than symptoms." Win is also active in the community theatre in Belmont, where his recent roles include Paddy O'Dowd in Eugene O'Neill's "Touch of the Poet," Crabtree in "School for Scandal," and Thomas More in "Anne of the Thousand Days." He also sings with the Charlotte Choral Society. — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

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A note from Colonel **Fred Elser** tells that he has obtained his master's degree and has now started his first class toward his Ph.D. He expects to do a dissertation on the subject of amateur radio. You just can't keep a good man down. Early in April, he will be flying from Hawaii to Reno for a few days then on to Palm Springs and finally to Martinez, Ga. We hope he will spend time in Florida so that we will have a chance to get together with him and Mardy.

A number of classmates have inquired about the proposed mini-reunion in Puerto Rico. Although things look hopeful for it, as of this writing there is nothing definite to report. I expect to have something more to report in the next issue.

George Manter is still battling for healthful and mentally productive controlled environments in homes, schools, offices or any place where people should THINK and not have their health impaired. . . . **Bryce Prindle** has retired from full-time teaching at Babson College and now lives on Cape Cod. He is doing part-time research and development work at Woods Hole Oceanograihic Institution on deep-sea lines, fishbite problems, and some teaching in Environmental Science for Bridgewater State College at Buzzards Bay. . . . **Myrle Perkins** says he has been trying to settle a small house in Santa Cruz, Calif., where his family is finding the living pleasant enough but such a vast contrast with Europe. He likes the idea of a reunion in Puerto Rico and plans to attend. . . . **Al Sims** also hopes to make the Puerto Rico mini-reunion if it is held. He and Lillian spent part of January in Hawaii with an Audubon Study group.

Emile Grenier seems to be making some headway with Congress in his efforts to stress the dangers of auto air bags. . . . A clipping from *The Washington Post*, dated November 6, 1977, reports the death of **Burdette H. Buckingham** on the previous Friday at Holy Cross Hospital after a long illness. Burdette was responsible for much of the liaison with Army and Navy offices at Johns Hopkins University Applied Physics Laboratory. Born in Westchester, N.Y., Burdette became interested in radio as a boy and graduated from the Radio Institute of America and went to sea as a radio operator before entering M.I.T. During World War II he was assigned to Ramgarh, India, to head a communications school training Chinese troops for action in the Burma theater. In 1945, he became assistant chief of the U.S, lend-lease branch in Chungking, China. He left military service as a Colonel in 1946. Word has also been received of **Louis Morse, Jr.**'s death on December 10, 1975. Our deepest sympathy to their families. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; Assistant Secretaries: **Ben Steverman**, 260 Morrison Dr., Pittsburgh, Penn. 15216; and **John R. Swanton**, 27 George St., Newton, Mass. 02158

32

The mail bag was quite full this month. Received a very nice long letter from **Jack Kelman**. He went to work for Leitz in 1932. After the war years he started his own business wholesaling cameras for factories (for export only). Since he loved traveling, he thoroughly enjoyed visiting most areas on this planet many times. Since 1960 he has concentrated on Japanese cameras for Latin America. He spends two summer months in his apartment in Spain on Costa Brava, only one hour's auto ride from Southern France, where his French wife's family lives. All very convenient. When not traveling he resides in Nassau, Bahamas, which he thoroughly enjoys. His younger son Peter died at age 35 from non-kidney function, and his older son Michael is head of classical music for C.B.S. There is more to his newsy letter which I will save for a later date.

Lee T. Tyburski plans to retire soon. In anticipation he has bought a one-acre winter lodge on Lake Blytheburn in the Poconos. He also is looking forward to traveling across the country and visiting his son Tom and daughter Thea in California. . . . **Robert S. Prescott** has just returned from a very interesting trip to Kitt Peak with the M.I.T. Club of Arizona. Bob had a slight stroke in July from which he is making a very good recovery.

Alvin B. Newton is supposed to have retired from Borg-Warner six years ago. However, he is busily engaged in very interesting consulting work. This year he has spent several weeks in Taiwan working on geothermal power generation. He has spent considerable time in Sydney, Australia, where he was concerned with solar heating and cooling of buildings. He also presented another paper. When not traveling, he is in Washington with D.O.E. His basic work is with alternate energy sources and implementation. . . . **John C. Lyon** writes that he is retired and enjoying it. His main hobby is sailing. He is a member of the United States Power Squadron and the Franklin Institute Volunteer Activities.

We have received the sad news that **Alva T. Wilson** of Burnsville, N.C., died on October 12, 1977. . . . We also have the obituary notice of the passing of **Frederick E. Mader**. He served for 40 years with the Insurance Services Office of New England. He specialized in engineering problems in relation to safety. Perhaps his most noteworthy contribution was a tornado report in central Massachusetts in 1953. This report was circulated by insurance companies throughout the country. He is survived by his wife Irma, a son and a daughter. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

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To start with, reporting some Christmas cards: **Slick Henderson** writes of his retirement from Sverdrup and Parcel; he's now Trustee of his original alma mater Westminster College, Treasurer of the Edgewood Children's Center, and on the Board of the local library. . . . From Ruth and **Bob Timbie** (I get a thrill from such an old and true friend of close to 50 years): they spent the summer visiting grandchildren in Belgium. Number two son married a charming girl in Arlington, Va., in July, with 14 Timbies attending; number two granddaughter starts college in the fall. Ruth keeps busy at her various hobbies, also keeps Bob busy upon capture — though he may also be found on the golf course. . . . A real nice card from Charalee and **Dick Fossett**: they took several ski trips early in the year, two Hawaiian skiing trips, and then a Caribbean cruise at Christmas time. Dick has resumed his amateur radio work (W6PTA) and continues in local community affairs.

Katherine and **Carl Swanson**, via card, wish us good health in the coming years, and thanks to them both. . . . **Dick Smith** of Chicago and Key Biscayne took a long trip this year — most of Europe and about all of the Middle East. "Once in a lifetime, and glad to be back," says Dick, who drew us a small map of the itinerary. I was curious and counted the stops — 20. Not bad. I'd be glad to be back myself! . . . **Horace MacKechnie** still on the same job with the Defense Department (he expects to retire at 70, next year) and still working with the University of Pennsylvania Medical School on an experiment to eliminate his gallstones without surgery. Last spring the MacKechnies went to Florida, visiting the Tampa area, Walt Disney World, and Cypress Gardens, et al.; then to England on a Defense Department charter touring the island in toto and visiting friends — all this in a Volkswagen bus. Then in the fall back to the home grind: church work, Bible class, and a Fairs and Spares group. . . . Doris and **Len Julian** are a remarkable pair — busy beavers, I call 'em. Doris is braiding rugs and chair seats, cutting the braiding pieces from fine wool to size. Len continues making gold and silver jewelry, works in wrought iron, and does enamel work on copper and steel. Doris went to Bermuda for a duplicate bridge tournament in February and before that both visited Palm Beach for a short vacation. Len says they have a strong feeling that they might take in the Fiesta in Mexico in March — you will love it, Len and Doris, as all of us before you have. . . . Jermain and **Jack Andrews** check in with a report on a trip west and a promise to attend the 45th; great, and many thanks. For years on end Jack has been active in the M.I.T. clubs in New Jersey, and he can be given full credit for starting the new one in Princeton. . . . Gossip tells Jack that **Mel Erlich** has retired from Mobil Oil research — no details; how about you telling us, Mel?

Walter Galazzi has retired from York/Borg Warner as Chief Engineer, and it's refreshing to hear that an old New Englander has found it desirable to retire to New Hampshire instead of Tampa Bay. Let him tell a little of his own story: "After 42 years with the firm I retired in December, 1976, and moved to Sunapee, N.H., where Ann and I spent a busy summer watching our new home go from the drawing board to a reality."

A short one from President **Dayton Clewell** serves to greet me personally and appoint me to the Nominating Committee; for we do have some electing to do, though **Ellis Littmann** is heir-apparent these five years and y'all may rest assured that he will be uncontested.

Walt Skees of Barcelona and way stations has sent me maybe 15 postcards over the years from the Bahamas and Spain with pretty pictures and signed by his personal rubber stamp. I chided him a bit but got nowhere. Now comes a real fine note, written from the U.S.A. while visiting. For Walt now admits that he has decided to take up residence in Spain, most probably Barcelona. . . . **Paul Genachte** writes again from Madrid, saying that he has sent **George Stoll** the ten dollar 45th fee; he's not too sure of attending but wishes to be paid up just in case he and his wife Susanne may make it.

Speaking of the 45th, **Harry Summer** is in a quandry: he finds that his 50th Brookline High School reunion may cause him to miss our 45th — imagine! Harry intends to retire very soon and isn't happy about that.

John Rumsey writes that he is living what appears to be an ideal life — working part time and vacationing the rest, which in his case means working part of a year and then travel the rest of the time. The Rumseys are just back from a fascinating trip to Japan, Hong Kong, Thailand, Malaysia, Indonesia, and Hawaii. Last winter they enjoyed some cross-country skiing, as the slopes were too crowded. They attended a fine retirement party for Howard Reichart, '34, at Mystic, Conn. John's son Ralph is a partner in a law firm in Ann Arbor; daughter Susan is living in Grosse Point, married with a 2-year-old son. John expects to be at the 45th.

Now for a most tragic, heartbreaking event. A clip from the *New York Times* of January 5 told of a mass shooting of **Chuck Thumm**, his wife, and two employees of the Arizona dude ranch. Ellis Littmann, who visited Chuck many times at the ranch, talked to a Tuscon reporter who added details. The murderer rode off in Chuck's station wagon and was captured a few days later in El Paso. Since then **Cal Mohr** has suggested that there ought to be some sort of memorial to Chuck from his classmates, and Ellis has asked Cal to head up a drive to collect enough to purchase a seat in the new Room 10-250 at the established price of $2,000.

We have had two more deaths this time around: **Gerald O'Connor** of Revere and **Fred L. Brugger** of Cambridge. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, N. H. 03833

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From not having enough to make it worthwhile sending in anything for the January issue I am in the happy situation of having more than I can use at the moment. So if those of you who were kind enough to say something on the Alumni Fund responses will bear with me, I'm going to devote most of this month to material which had been sent to me in the past six weeks or so.

Several of them are in the form of Christmas letters. First from **Bill Leete** in Sarasota — at least that's where he lives when he's not flying around Florida and the South. Obviously most of the news worth mentioning involved bad weather situations and visits from old friends. The weather pursued him with his motor home — either cold temperatures or heavy rains. Further gleanings bring out the following: Joe Dow, '35, and his wife Ann live in an apartment that Bill still owns on Siesta Key; Bill's son Bill is Assistant Treasurer of the City Trust Bank in Bridgeport, Conn.; and finally that Bill suffers from a disease common to retirees — "committeeitis": he is a director of the condominium in which he lives and has been President and Treasurer in the past, also Treasurer of the Siesta Key Condominium Council and Director of the Siesta Key Fire and Rescue Advisory Council.

Being grateful for small favors, I disregard **Bill Ball**'s remarks about a Christmas letter being the lazy way of keeping us up to date. Going through it, I find a good deal of interest to Bill's M.I.T. friends. He retired last June from the National Association of Manufacturers, and, as he says, "since most who receive this letter are retirees, I need not describe how busy we are in retirement." Both he and his wife Lois remain active in church and local affairs. Their daughter Nancy was married last May to Stephan Lesher, an executive of Rashoon Communications, who handled President Carter's 1976 campaign. Their son Dick is still in nearby Greenwich where he has left Celanese Corp. to go with the Bowater Paper Co., a British concern. Of major interest to me is that Bill and Lois are househunting in Connecticut and Cape Cod and hope to do some looking in Dennis. His father, William, Sr., Class of '05, had lived on the Cape for many years.

Those who were at our last reunion may remember that at that time there was discussion of the Institute's efforts to have returning classes hold their reunions on campus. At that time there were no specific programs available and the whole idea got a rather lukewarm reception. Without any attempt to push the matter just now, I can tell you that things have changed a lot in the intervening years. On January 30th **Larry Stein** (he's one of your Vice Presidents, in case you've forgotten) and I took advantage of an Alumni Council meeting to discuss the present program with Joe Martori of the Alumni Association office. He is in charge of working with reunion committees and has a staff available at reunion times.

There are several options available to the classes, and by the time you read this we hope to have a committee together and working on the possibilities. I'm sure we'll solicit opinions but they must be able to offer something attractive — 10 of the 13 reunion classes this coming June are staying full-time on the campus.

Thanks for the holiday spirit that moved you to write so much — you can well imagine that I couldn't pry that sort of information out on my own. — **Robert M. Franklin**, Secretray, 620 Satucket Rd. (P.O. Box 1147), Brewster, Mass. 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, Md. 20015

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The 45th Reunion Location Committee seeks your suggestions. Jug End in the Berkshires, Chatham Bars Inn, Wianno Club, and Wychmere Harbor Club all on the Cape are some of the possibilities so far. The general plan is to stay at the M.I.T. dorms on Thursday, June 5, 1980, with perhaps a buffet before Pops and attend Technology Day on Friday through the lunch. Then drive to one of the resorts for the weekend. So please discuss this with your wife and drop a note to the committee chairman, **John Taplin**, 15 Sewell St., West Newton, Mass., 02165. Also speak about it to any other classmates near you. We have to make a firm commitment this spring and it might as well be to go to the place you would like best, or second best.

The following reports from former classmates came through the Alumni Fund, and we are delighted to have six of them to pass along to the rest of you. **P. Roland Hanson** writes: "I retired September 1, 1977, at age 65 after 34 years at Raytheon. My wife and I have purchased a house in Kingston, N.H., and we expect to leave Winchester, Mass., in February." Let's hope Roland took a snow shovel with him; it's up to the eaves at my family homestead in Sandwich, N.H. . . . **H. William Parker** dropped a note. "Have finally moved to Bella Vista, Ark., permanently and enjoy reading of ice and snow in the North while playing golf down here. P.S. How do I get into class golf competition?" Bill, the only address I have for you is at I.B.M. in Rochester, Minn. Please send me your present address and I will see that you receive the golf information; we'd love to have you in it. . . . **John Shaw Cort, Jr.** writes from Cleveland, "Am still enjoying retirement. It is nice not to have to plow out when there are 15 inches of snow on the ground and the wind-chill factor is well below zero. Am doing some work with SCORE which I find most interesting and varied." . . . **Franklin F. Lovering** writes from Texas, "Retired after 42 years with Phillips Petroleum on July 1, 1977. Enjoying every challenging minute of it. Spent 45 days this fall in the Northeast. Have daughter in Ramsey, N.J., sister in Conway, N.H., brothers in Framingham and Centerville, Mass., and wife Ruth has sisters in Bradford, N.H., and Torrington, Conn. May spend summers on Cape Cod. Understand **Hank King** and others are in Chatham." For your information, Frank, Hank King's phone is 945-9075. **Bernie Nelson** is President of the Cape Cod M.I.T. Club and can put you in touch with the other '35ers on the Cape. His phone is 423-5574 in South Harwich.

Blake Mills writes from the State of Washington: "After teaching M.E. at Tech for five years and 31 more at the University of Washington, I retired in June, 1977. Still play hand ball." . . . **John C. Alden**'s note comes from nearby Concord, "My wife took me on a month's trip to the Kingdom of Nepal, October, 1977. We were with an A.M.C. group led by "Ted" Felback, '49. We spent three days at Trekker's Lodge, Thyangeboche, elevation 12,700 feet with good views of Mt. Everest. Went Air India both ways." Since the opportunity to see Mt. Everest has always been one of my goals, I called John for more details. They were on the trail for three weeks with porters and sherpas and slept in pup tents going to and from the Trekker's Lodge and Katmandu, a distance of only 80 miles but lots of ups and downs "like climbing the Grand Canyon twice a day," according to John. I've already decided to go by helicopter! What a fantastic trip that must have been; I'm breathless, and I do the Royal Canadian Air Force exercises regularly. . . .

Some day soon I hope you will get the urge to send me an opus, letter, card, or even give me a telephone call. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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It is now late January and just three days ago I spent a most enjoyable time shopping at the Tech Coop and wandering through the familiar, and some not so familiar, halls on my way to the subway at Kendall Square. I took time to peruse the Karl Taylor Compton exhibition under the dome on the first floor of Building 10. It was certainly a nostalgic tour and you can imagine my surprise as I gazed at a display case to note on a card that the M.I.T. Historical Collections was indebted to **Martin Gilman**, '36, for the contribution of several freshman handbooks included in the display. Of this, Martin himself writes: "In going through old files I found a number of items dating from our days at Tech. They were things I could now easily throw out but I took them to the M.I.T. Historical Collections and let them do the evaluating. They are happy to have anything old and some of the things they were glad to get. So don't throw anything away — let the archivists and historians make the choices." So take note, everyone, as you prepare to move to smaller homes or distant climes, those memorabilia may be important to someone!

Larry Kanters wrote in early December that he was headed for Ft. Lauderdale on a medical leave of absence for three or four months of physical therapy. He may still be at 81 Bay Colony Dr. when you read this and if you are in the neighborhood he'd like to see you. . . . **John Rowan** reports from Clearwater Beach that he is enjoying retirement with some consulting work. He summers in Ontario. . . . The **Robert Newmans** (she was a special student at M.I.T. in 1941) spent seven months touring the periphery of Latin America, visiting most of the ancient archaeological sites and all

but three of the South American capital cities. They report that their 1975 Plymouth Duster worked well at 15,000 feet.

Raymund McGrath retired from Chicago Bridge and Iron Co. in September, 1976. He is a consultant to the American Petroleum Institute and is chairman of the Planning Commission of Palos Heights, Ill. . . . **David Macadam** retired from Eastman Kodak in August, 1975, and is currently Professor of Optics at the University of Rochester. He is also editing the *Springer Series in Optical Sciences*. The Macadams have found time, however, to enjoy the M.I.T. Quarter Century Club Scandinavian Tour last fall and plan a Greece and Greek island cruise with Kodak employees this spring.

The Alumni Office reports the death in February, 1976, of Dr. **Harry Kelly** whom you may remember as a teaching fellow in physics our freshman year. He had been Dean at North Carolina State University in Raleigh and had many years of service in Washington where George and I used to encounter him periodically. I have no further information about him. — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

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Fred Altman is still consulting and recently gave a paper on "Occurance of Intense Rainfall" at LaBaule, France. He also visited Brittany and Scotland chasing megalithic monuments. . . . **William McHugh** has retired from Massachusetts Department of Public Health and Massachusetts Hospital for Handicapped Children. . . . **Ed Corea** is retired and is doing consulting work. He and his wife Marie enjoyed a visit to Koln, Germany with their daughter Gena and her husband Tom Marlin. Gena's book, *The Hidden Malpractice*, about women and the medical profession, was published last April and is coming out in paperback this spring.

John Hanlon, manager of dyeing research for the Mohasco Corp., Amsterdam, N.Y., has been named the recipient of the Harold C. Chapin Award for outstanding service to the Amsterdam Association of Textile Chemists and Colorists. John joined Mohawk Carpet Mills in 1939 where he pioneered in the use of spectrophotometry and colorimetry for the color measurement of textile materials. . . . **Joe Smedile** is with the Northwestern Illinois Planning Commission trying to finalize wastewater plans for the six-county area centered on Chicago. It was great seeing Joe and Martha at our 40th reunion, and Joe in his Christmas letter said he was happy to report that Martha is holding her own.

Ginny and **Jack Simpson** sent your secretary a Christmas card on which they mentioned that they had a micro-reunion in Florida with June and **Walt Wojtczak**. Jack also inquired about **Leo Avondoglio**. If anyone knows Leo's address, kindly let your secretary know and we will get back to Jack and the Institute. — **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, Mass. 02148

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A portion of our 40th Reunion Gift was officially turned over to M.I.T. last December 2. At a dinner at M.I.T. **Norm Levanthal**, our class president, formally presented the Margaret Hutchinson Compton Gallery in the Alumni Center to M.I.T. Mrs. Compton was present, and was made an honorary member of the class. On display in the Gallery was an exhibit entitled "The Compton Years," a photographic essay on the lives of Dr. and Mrs. Compton. When you come up for the 40th Reunion, I strongly urge you to pay a visit and see what the class has been able to accomplish.

Dick Muther, President of Richard Muther and Associates, Inc., of Kansas City, Mo., last fall presided over the Annual Meeting and Research Conference of Muther International in Sydney, Australia. Muther International is a group of consulting firms specializing in the areas of industrial engineering management. . . . **Sid Baron** writes that he retired last year from the Navy U.S.C. after 37 years in the civil service in the Navy. He now spends most of his winters in Georgia and Florida, and claims that golf and tennis keep him young. . . . **Ed Myrick** is still working on flight test program planning for new aircraft, but he does plan to retire in 1979.

Bob Solomon writes that he is a Professor of Pathology at the Unviersity of Missouri, Kansas City, where there is a newly-organized innovative six-year medical school. He also comments that they are studying the mechanisms of aging, important for the Class of 1938. . . . **Saul Jacobson** has been retired from Brunswick Corp. since 1972. He does some consulting and serves as a director for two manufacturing companies. Saul is living in Santa Barbara enjoying the climate and recreational facilities. He is active in the Santa Barbara Symphony Association.

Ham Radio Operators please note — **Tom Garber** refers to a suggestion of **Cliff Nelson**, W1IDA, Gorham, Maine, that the Class of '38 Hams get together on the airwaves. "On the first Sunday of each month at 9:00 a.m. on 3955 (+ or -5 kH.) I usually chat with Cliff. Other classmates are invited to join in." Tom's call letters are WA1TGY, Acton, Mass. . . . We had a Christmas card from Joanne and **Arch Copeland** informing me that Arch took early retirement and has moved to a new home in central Arkansas.

Part of the aging process referred to earlier brings me to the sad notes. **Harold Davis** passed away last fall. Harold was living in Norwell, Mass. . . . **Frank Hagerty**, who was part Class '37 and part Class '37, passed away in December, Frank, if you remember, had started a mail order furniture business for do-it-yourselfers to make reproductions of museum-piece furniture. . . . I received a belated announcement that **Harry Hollander** passed away. I was surprised that I didn't read this in the local Cape Cod newspaper. You will remember that Harry was living in Truro and did teaching and writing in art. . . . **Severino Rugo** passed away late last fall. . . . Lastly, **Herman Schaevitz** was killed in a traffic accident this fall. Herman had been an instrument technologist, and had developed the Linear Variable Differential Transformer.

By now I am sure that most of you have signed up for the 40th Reunion. **Ed True** tells me that the attendance will be phenomenal. **Haskell Gordon** states that we are really moving on towards a record Class Gift, and **Ed Hadley** is working all out to get the class book ready. Be sure you have sent in the replies to his questionnaire so that the book can be as complete as possible. — **A.L. Bruneau, Jr.**, Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

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Jim Barton and Mary have reported from their beautiful estate on Lake Washington that it has not been washed away by storms and that, nevertheless, they proposed to spend ten days or so on the Kona Coast of Hawaii during February.

George Cremer and Billie returned from a trip to the Far East and Hawaii just in time to retire, George from a 27-year career at Solar Aircraft, and Billie from Monte Vista High School. At the moment they are arranging their house for rental before they go off again, this time on a nine-plus month tour of Spain, France and England from where they will send news bits to you via this column.

Dodie and **Bob Casselman** have moved to Brookline to be closer to the Museum of Fine Arts which is reported to be undergoing a kind of rebirth under the loving care of Dr. Casselman who is being assisted and inspired by Nurse Dodie. In his spare time Bob wrote a book, provisionally named *When It's Over, Over Here*. When the real title and the publisher are announced, you'll find in these notes how and where to get your copy. . . . **Sam Davis** was elected Mayor of St. John, New Brunswick, the oldest incorporated city in Canada. We all wish you good luck, Sam.

Norris Dow has been awarded the Edward Longstreth Medal for developing the triaxial method of weaving and for developing a practical loom for its manufacture. Norris' invention improves the durability of fabric, and it has been applied to inflatable buildings, liferafts, aircraft escape slides, blimps, weather balloons, hang gliders, tarpaulins, tents, conveyors, and body armor. Norris is chairman of his own company called King of Prussia, and his medal is for invention of high order and particularly meritorious improvements and developments in machines and mechanical processes.

We were saddened to learn of the death of **Charles E. MacKinnon** in Houston, Tex., on January 10, 1977. There were no details. — **Hal Seykota**, Secretary, 1421 Calle Altura, La Jolla, Calif.

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Cheering news from a lot of Alumni Fund envelopes dispelled any notion that everyone is in Tahiti or polishing gem stones.

Base Broadening. **Edmond P. DiGiannantonio** continues as Assistant General Manager of EDO Corp.'s Washington office and works "to broaden EDO's base to all government agencies in addition to the Defense Department."

Steady as You Go. **Abraham P. Rockwood** says, "...still employed at Maurice A. Reidy Engineers in Boston, and still living in Needham."

Village Life. **Edgar W. Adams, Jr.** summarizes, "Now and for last 26 years living in village of Brookside, N.J. Continue as patent attorney at Bell Labs since 1946. Betty (Wellesley '41) and I have three married sons and two grandsons, one just arrived. Leisure: travel, sailing, farming beef cattle."

No Slacker Here. **Clare L. Milton, Jr.**, down Baltimore way, writes, "After 26 years at Roper Eastern, most recently as Vice President — Technical Services, and with the completion of the development of a coil coating oven of unprecedented thermal efficiency, I have joined Slack Associates as Vice President and Technical Director. Slack is a firm of consulting and manufacturing engineers specializing in special equipment for high vacuum, optical fibers, environmental testing, and solar industries."

Get Up and Go. **John C. Quady** confirms our report of last May: "Senior Project Engineer, working on design of hull system of U.S. Navy 3,000-ton high-speed surface-effect ship." This little jewel will get up out of the water and go.

Radiant. **Charles S. Godfrey** has left Physics International and returned to the Livermore Laboratory, Berkeley, Calif.

Fluid Drive. **Wensley Barker, Jr.** in West Hartford, Conn., is now Regional Products Manager at Altair, Inc., a manufacturer of fluid power components for aerospace engines, airplane, missile, and submarine applications.

Heavy Water. **Martine A. Antman** reports, "Working in West Palm Beach for the South Florida Water Management District, with responsibilty for electronic communications, data acquisition, and supervisory control. Have been getting to most meetings of our recently-founded M.I.T. Club of the Palm Beaches."

DEPARTMENTS. *In the Thereafter*. **Edward S. Carmick**, in Saratoga, Calif., checks in: "I am now fully retired, keeping up a big garden on two acres, craft hobbies, reading history, frequent travel, recently to New Zealand and Australia to visit World War II friends." *The Happening*. So far no further news regarding feelings or plans for the 40th reunion. We need your thoughts! — **Frank A. Yett**, Secretary, 1405 Ptarmigan Dr., Walnut Creek, Calif., 94595

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Loch Ness Monsters — Who in our Class believes there are 20 to 30 foot large animals in Loch Ness? Why **Charles Wyckoff**, the Boston Academy of Applied Science photo expert. He has anchored four "monster pots" in the Loch for

year-round observation duty. Each cylinder contains a 35-mm Nikon camera, a strobe-light unit, a 250-exposure film magazine, sonar and a computer. The computer will tell the camera to shoot whenever anything two to three feet thick comes within clear view. Does Mr. Wyckoff believe there is a monster in the loch? "Absolutely, no question about it," he responds. "They're not monsters. They're large animals — in the 20-to-30 foot range."

Seduced by a condominium — **Zack Abuza** writes, "After five years of retirement I got seduced into building a nine-unit condominium here on Longboat Key. All new experiences and lots of excitement. Looking forward to retiring again when the project is complete in March."

Fry up Matterhorn — Our mountain climbing classmate **Sam Fry** writes, "First grandson, in Germany, occasioned visit to Tubingen and side trip to top of Matterhorn — subsequently acquired second German son-in-law in country wedding near Dinkelsbuhl. Still working for Boeing on U.S. Roland — a French/German developed weapon system."

Bullet Train — **Ivor Collins** writes, "Shirley and I enjoyed a great trip on our vacation: four weeks to the Far East and Hawaii. We visited Tokyo, Nikko, Kamakura, and Kyoto in Japan, and had a ride on the "Bullet Train" (and that is really railroading!); Taipei, Taiwan; Hong Kong; Bangkok, Thailand (probably the most spectacular of all, with its dozens of ornate temples); Kuala Lumpur, Malaysia; Singapore; Jogjakarta and Bali, Indonesia; and rested up with two days at Waikiki and two days on the 'big island.' Unforgettable!"

A.I.D. — **Henry Arnold** reports, "I am completing my fourth year as Director of the Office of Science and Technology for the Agency for International Development (A.I.D.). Our job is to find new ways that science and technology can help poor countries to develop."

Father-and-son act — We learned from **Ken Roe**, Chairman and President of Burns and Roe, Inc., engineers and constructors, that with his son Keith Roe he presented a co-authored technical paper at the recent International Conference on the Optimization of Sodium-Cooled Fast Reactors in London, England. The conference was sponsored by the British Nuclear Energy Society. The subject of the paper was "How the Architect-Engineer Manages Design Objectives and Restraints for Optimizing Sodium-Cooled Reactors." Keith Roe joined Burns and Roe, the architect-engineer for the Clinch River Breeder Reactor, in 1974 after receiving his M.S. in Nuclear Engineering from M.I.T. where he studied under a Sloan Fellowship. Keith was most recently Assistant Project Manager on the Prototype Large Breeder Reactor Project. He is currently project engineer on a major nuclear power plant project.

That woman in the west wing — A *New York Times* article by that title concerning the first female Assistant to the President, Midge Costanza, had the following to say about one of our erstwhile political classmates: "Her best male friends appear to be John G. Heimann, U. S. Comptroller of the Currency, and veteran New York politician **Howard Samuels**."

Keep sending in the news. — **Henry Avery**, Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn. 15230

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In the congrats department: **Michael Bever**, who received his graduate degrees with our class, has been elected a Fellow of the American Society for Metals in recognition of "distinguished service and contributions in the fields of materials and metals"; and Professor **Robert C. Seamans**, formerly head of the U.S. Energy Research and Development Administration, has been awarded the Ralph Coat Roe Medal for "service as a public servant and as an educator."

Two reports from downeast in Maine. First, **Bill Hendrich** has opened his own office for the practice of Structural Engineering in Auburn. He will welcome any business coming his way. Second, **John Jorgensen** "feels like a millionaire" since his move to South Bristol, Maine. This was in 1972 so it is not really hot news. He writes that he has time to smell his roses and to appreciate the local lobsters. Also, he boasts that there is plenty of room to breathe — the phone directory for all of Lincoln county is about the size of the *Reader's Digest*. Not sure whether he intends that as a commercial for the magazine, Ma Bell or for his adopted county!

Ed Holland, our World Bank economist, has retired after nine years of analyzing various aspects of international development. His most recent project was on the economics of urban transport in different parts of the world. However, he forgot to tell us where he plans to transport himself in retirement. Ed, please do send us your address.

A plug for Bob Radocchia's Quarter Century Club's trips from **Elizabeth Kelly**. She went to Sicily with the group and says that the trip was very well organized and that she enjoyed it immensely.

One obit: **William S. L. Christensen** of Course I died on November 10, 1977. He had been President of WMC Incorporated in Winona, Minn. Our sympathy is extended to his family. — **Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

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Mort Spears wrote, "Have been with Spears Associates, Inc., electronics manufacturing, antennas and communications. Have gone from 5 to 82 employees in seven years. We gross over $3 million per year; our work is mostly for military." . . . Dr. **Robert H. Scanlan**, Professor of Civil Engineering at Princeton, who received his doctor's in mathematics with our class, is on leave this semester. He will teach special courses on wind engineering at Rice Universtiy, Houston, and at University of California at Berkeley. These courses will be based on his forthcoming book, co-authored with Dr. Emil Simiu of the National Bureau of Standards, entitled, *Wind Effects on Structures*, to be published by John Wiley and Sons.

Loring "Hap" Hosley, president of Loranco, Inc. of Philadelphia, suppliers and installers of material handling equipment, wrote, "Living in Allenhurst, N.J., by the ocean. Of my five children, four are now in college, most leaning toward engineering and management. None want any part of their own business, like I did."

Don't forget our 35th reunion, June 8 to 11, 1978! — **Richard M. Feingold**, Secretary, 779 Prospect Ave., West Hartford, Conn. 06105

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The 35th is still planned for Bermuda in June, 1979. If any of our classmates has a brilliant idea for a different place please let us or Ruth and **Norm Sebell** know. In planning for the 34th we wrote to Elvira and **Arturo Morales Dominguez** about the possibilities of a Mexico City event. As we expected, the Morales were extremely cooperative; sent us information almost by return mail, in two separate packets. This information, together with data on airline fares and special tours gathered by Edna Warshaw, was reviewed at a committee meeting one snowy night at the home of Edna and **Stan Warshaw** in Newton. (Even if we were not planning an innovative 34th, these meetings would be worthwhile. There have been more classmates at the last two meetings than we usually see on Alumni Day and the atmosphere has been superlative. If we could send out samples of Edna's lemon and cheese cakes, we could probably get 90 per cent of the class to a reunion at *their* house!) We reviewed our plans against the following criteria: — The 34th should not detract from the 35th planned for Bermuda. — The 34th should be held during the first two weeks in May, thus avoiding commencements at M.I.T. and at public schools (most companies begin their "vacation year" in April). — For maximum participation in an off-year (indivisible by five) the event should not cost more than $750 to $800, and less than half that cost should be air fares. — The increase in air fares (since 1974) has been quite large. — The location should be easier to reach (for most alumni) than Cambridge, but within reasonable driving distance from Cambridge. With these criteria, and with the knowledge that the Morales would be away on their own trip in May, the committee opted for some place half-way down the Atlantic coast, near Norfolk, Virginia (and Williamsburg) for example. The exact place will depend upon further research which will be reported at our next meeting (at the **Ahlbergs'** in Sudbury, Mass.) in February. The budget (if there is one!) doesn't permit our writing to each of you. Please write or call either Melissa and me or — even better — **Norman Sebell** (committee chairman) at 100 Burlington St., Lexington, Mass. 02173. Your thoughts, suggestions, preferences, objectives, diatribes, etc., on how much, how far, and how long on either reunion are needed. We need maximum participation in planning, as well, even from those who may not be going. If you won't be attending either reunion — or both — send a card explaining why not, and what kind of event you *would* attend.

FLAP FACTS: **Robert R. Morse** (XV) announces his marriage on July 24 in Ithaca, NY. . . . **David Z. Bailey** (XIII) presented a paper at the Miami International Conference on Alternative Energy Sources in December. His talk was on "Energy from Sea and Air by Large-Span Tensional Foils" — good suject for a Rhode Islander!

From Venezuela, **Jose M. Aguila** (II) sends us a short adventure story on his newly-acquired (or exercised) hobbies: skiing and boating, at Zermatt, St. Moritz, and Courchevel, no less. By now, the Aguilas have returned with their four boys (5, 7, 9, and 11 years old) to Courchevel. They spent the Christmas holidays cruising the Caribbean in the 36-ft. Grand Banks trawler they bought a year ago. (Maybe they'll take the trawler to Bermuda in 1979!)

Peter D. Matthews (XV) (Assistant Treasurer of Draper Lab in Cambridge) has his son Pete, Jr., working as a programmer at the Lab. Pete, Jr., and his wife, Val, have a 1-year-old daughter, Morgan. Second son, Don, a Needham lawyer, is a candidate for the Massachusetts Senate this year. Daughter Andrea graduates from Princeton in June.

From Chicago, **Don Arsem** (VI) (chief executive, etc., at Wurlitzer) is active in the alumni group planning a spring M.I.T. Management Conference. He expects to receive his M.B.A. from Northwestern in May but to keep his hand in, he's been teaching part time at Loyola Graduate School of Business — and enjoying it. . . . **Howard Weaver, Jr.** (X) has had an uninterrupted career with Cabot Corp., "its predecessors and subsidiaries," since he graduated. He's now a chemical process engineer in the Central Engineering Division.

There are also farewells: **Charles F. Lenhard** (II) died on November 24, 1977. He was with Ilikon Corp. Earlier he was head of Diversa-Graphics, Inc., which he helped to create. . . . **Wallace P. Dunlap** (X) died on May 19, 1977. He was director of Planning for Monsanto in Missouri. On behalf of the class we extend our condolances. — **Melissa** and **Newton Teixeira,** Secretaries, 92 Webster Park, West Newton, Mass. 02165

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Melvin B. Zisfein was awarded the Smithsonian Exceptional Service Gold Medal on November 18, 1977. Melvin became the Deputy Director of the National Air and Space Museum in early 1971, joining this area of the Smithsonian Institution after his career as an aeronautical engineer and aerospace manager. The award complimented Melvin on his fine and successful work in the researching and completion of imaginative and efficient exhibits, the preservation and restoration of artifacts, collections and the general museum administration.

Don Burke and three friends formed their own firm, Fischer, Johnson, Allen and Burke, Inc., on July 1, 1977, in St. Petersburg, Fla. The firm acts

as a dealer and consultant in municipal bonds and works directly with the client. Don says it is fun to feel free to work longer than 8:00 to 5:00 and only five days per week. . . . **Henry I. Stahr, Jr.** has become Quality Assurance Manager of Switchgear Division in Pittsburgh. His daughter, Carol, is a freshman at Wellesley. . . . **Robert F. Nelson, Jr.** writes to advise he has moved from his five-bedroom house in Rockville, Md., to a three-bedroom townhouse. Only the younger son is still at home; the older son is now in the Navy and the Nelson's two daughters are in college in Califiornia. The Nelsons' new address is 8 Great Pines Ct., Rockville, Md. 20850.

Morris A. Chomitz writes to say he was promoted to Vice President of Engineering at Day and Zimmerman, Inc., Engineers and Construction Division, Philadelphia, where he has been since 1965. His son , Ken, M.I.T. '75, Course XVIII, is now in California pursuing his Ph.D. in economics. . . . **Ernie Buckman** has proudly advised that he has purchased Oliver Realty, a former subsidiary of Oliver Tyrone of Pittsburgh. "A great feeling to own your own business, a firm employing 54 people in the property management business!"

Recently the New England Merchants National Bank gave tribute to famous New Englanders. One of these was Nathaniel Bowditch, who wrote, "The New American Practical Navigator in 1802." Our **Phil Bowditch** is like his great-great-grandfather, Nathaniel, as he has always had a fascination with the sea and the measurement of physical phenomena. Phil is the head of the Scientific Research Department at the Draper Lab, meeting challenges in oceanography and other fields. . . . **Merwin R. Burman** has been made a partner in the law firm of Fink, Coff and Stern. . . . Major General **Hillman Dickinson** has been re-assigned from Washington, D.C., to Fort Monmouth at 36 Russel Ave., Fort Monmouth, N.J., effective December 20, 1977.

Until next time — **Russell K. Dostal**, Secretary, 18837 Palm Cir., Cleveland, Ohio 44126

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Leading off this time is our Bridegroom of the Month, **Dan Carnese**. Dan was married in December to the former Lee Parrott, a friend of 25 years and the widow of a close friend. Lee has four children: Tom, a carpenter-farmer in Lake George; Jana, a photographer with Chromalloy; Cyndi who is beginning a program in design in San Francisco; and Marisa, a freshman at Franklin Pierce College in New Hampshire. Dan's daughter Diane is a junior in communications at the University of Delaware. I see Dan, Jr. occasionally around the Artificial Intelligence Laboratory at M.I.T., where he is a graduate student in computer science. Dan, Sr. has recently joined VanDyck in Westport, Conn., consultants in industrial design, new product development, and market research. He was formerly with the University of Bridgeport for six years as their Director of Cooperative Education. Prior to that he was in helicopter design and development, with Vertol Helicopter Corp., Republic Aircraft, and most recently Sikorsky Aircraft as their Chief Flight Test Engineer and Supervisor of Aerodynamics.

Bob Creek is our newest 10-250 chair occupant. Bob is with the Union Oil Company of California, living in Schaumburg, Ill. This makes an even dozen Class of '47 chairs now in THE SEVENTH ROW. Any bakers in the class?

Congratulations to **Harold Raiklen**, with Rockwell International, who writes: "Our B-1 Bomber Team was awarded the coveted Collier Trophy earlier this year. Our third one: F-100 and X-15 were prior awards."

As part of a semi-sabbatical, **Robert Drye** taught Transactional Analysis workshops in Australia, Toronto, Chicago, Vermont, and Puerto Rico. He still has a busy office practice, and with children distributed from Oregon to Dartmouth, he has a head start on planning this year's trips. Bob is based in Carmel, Calif.

An up-date on **Ben Craig**'s extra-curricular activities: since 1976 he has been the Heart Fund Chairman, Alabama Region 8; in 1962 he was Chariman of the United Fund, Florence, Ala.; President of the Alabama Branch of the Associated Contractors of America in 1974; he was Mayor of Florence from 1966-1969; President of the Florence Lauderdale Industrial Committee (1964) and of the Chamber of Commerce (1959); and he has been an Elder of the First Presbyterian Church of Florence since 1961. I think Ben shows leadership potential.

Thanks to all (mentioned above) who took the time to write a few lines on the Alumni $$ envelopes. If you feel like writing more (still with postage prepaid and the envelope already addressed), you can put a note in with your money. Put your name and class at the top of the sheet. Address, too, if you feel ambitious. It will keep my records updated. See, I don't write about myself when you send material. Besides, I am busy learning how to do what you have been doing all these years: writing proposals. If you have an agency or foundation interested in funding a project to teach inner city, mostly minority, high school kids in a demanding technical environment — using LOGO (see December notes) — please let me know.

Love to all. — **Ginny (Ms. Virginia) Grammer**, Secretary, 62 Sullivan St., Charlestown, Mass.

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The response to the mailing for our 30th Reunion has been excellent. **George Clifford**, Reunion Chairman, wrote to all 1,200 members of our class and 18 per cent had responded by January 15. Sixty-six classmates are definitely planning to attend the reunion and there are many "maybe attending" responses. **Don Noble** is chairman of the Program Committee for the reunion. He has asked **Bob Sandman**, **Nick Caldwell** and me to meet with him to plan the program. Among the possibilities is a bus trip to Faneuil Hall after the Pops for a late evening snack and drinks. At Chatham Bars Inn during the weekend there is the choice of a clambake or dinner dance; golf, tennis, or swimming; or all of the above. The reunion will begin on Thursday, June 8. Friday is Technology Day on campus and the class has reserved Chatham Bars Inn for the weekend.

Joan and **Curtis Green** invited me to dinner at their home in Tulsa. Joan is a wonderful cook and excellent hostess. Curtis is still tending his existing oil wells, and he drills new wells periodically. Curtis asked about **Bob Wofsey**, so the following week I had lunch with Bob in New York. Bob is Director of Finance for Arthur Young and Co., Inc. Bob is unbelievably busy directing the start-up of systems and hardware to enable his firm to centralize functions that had been done separately at 70 branch offices. They have geared up considerably, but the more the department demonstrates what can be done the sooner it is wanted. This has required doing a lot on a manual basis while the system is built. Bob and Marcia live in Mamaroneck, N.Y., and he is able to bicycle to the train station. Bob's daughter is at graduate school in Rochester studying psychology. His son is studying law at Vanderbilt, and another daughter is at home attending high school.

Frank Jones has been reappointed for three more years to the board of directors of the Memphis branch of the Federal Reserve Bank of St. Louis. Frank is president of Cook Industries, Inc., of Memphis.

Art Renz has been elected a trustee of the Dartmouth Savings Bank in Hanover, N.H. Former sales manager and chief engineer of Pope Machinery Dorp., Haverhill, Mass., and sales manager of Split Ball Bearing, Art was also a founder of New Hampshire Industries. Since 1960, he has headed the pulley manufacturing firm which is now a unit of Wheelabrator-Frye, Inc. Art and his wife Barbara live in Hanover, and they have three children. . . . **Bill Hart** wrote that he is still employed by Hercules, Inc. (formerly Imperial Color and Wallpaper Corp.). He was recently promoted to Supervisor of Technical Services for the pigment division. Bill has been the Educational Council's member in the Glens Falls, N.Y., area for about 15 years.

Harry Meyer was appointed Vice President and General Manager of the Arrow Hart Division of Crouse-Hinds Co. He has returned to New England for this challenging job after three enjoyable years as Senior Vice President of Cherry Electrical Products in Waukegan, Ill. Harry hopes to be at our 30th Reunion. . . . **John Lake** is a Senior Civil Engineer with the New York State Department of Transportation and is heavily involved with rehabilitation of railroads and improvements of grade crossings. John's son Anthony was graduated from M.I.T. Course VI this year. Daughter Sarah is studying music at Sarah Lawrence College. . . . **Dave Freedman** sold his bakery in 1975 to retire to Florida, but got involved in retail stores. He helped get the new Quincy market started with his two sons. The store is doing very well, but Dave doesn't know "when and if" he will get to Florida. . . . **Jim Guida** wrote from Arlington, Vt., to say that he hopes to be at our 30th Reunion in June.

Milton Widelitz invested in Los Angeles real estate and has been developing condominiums and industrial projects. He also consults with other developers and owners in construction management. . . . **John Clifford** survived the blizzard of 1977 in Buffalo and was prepared to endure a hard winter this year. He is wiring houses in the Buffalo area as usual. . . . **Malcolm Reed** writes that "with the competent assistance of Linda Stantial and Diana Meade of M.I.T.'s Career Placement and Planning Service I am pleased to have moved to a new position." Malcolm joined Kurweil Computer Products, Inc., in Cambridge as Senior Mechanical Engineer. Kurzweil makes a reading machine and other devices used by the blind. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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A rare treat — letters from classmates: **Herb Federhen** replies to Paul Weamer's question in the November class letter as follows: "I certainly plan to attend the 30th Reunion, and I think that it should be at least partially on campus. Somehow, a reunion without an evening at the Pops wouldn't be right. Then a few days just before or just after the reunion weekend at either Bermuda or Cape Cod would be ideal. Bermuda would be preferable, but with several children still in college, Cape Cod would probably fit the budget better. I look forward to seeing you there." Thanks for your comments, Herb. Your views are exactly those of the class officers and the active class alumni we have talked to.

For those who like to plan in advance, the following time table is the most probable. The reunion will start with a class cocktail party and Tech night at the Pops on Thursday, June 7, 1979. We will remain on campus until early Staurday morning, June 9, when we will leave for an off-campus reunion site, probably on Bermuda. If we do go to Bermuda and adopt the standard three-night, four-day hotel package, we would return from Bermuda late Tuesday, June 12. Our current idea is to hold all official class functions (banquet, official meeting and elections) Friday evening. Since Friday is Technology Day with continuous activities starting at breakfast, it will be long and no doubt tiring, making Saturday morning's escape to rest and relaxation even more appealing. The first *official* information regarding our 30th Reunion will be contained in the mailing scheduled for October. By then we will know where we can hold the reunion, what transportation alternatives will be available, and what the approximate cost will be. If Eastern Airlines fly-anywhere fare is still in existence, many remote classmates may find that they can combine the reunion with visits to other parts of the United States, relatives, etc.

Jack Fogarty responded to my December "no news" announcement with his annual Christmas letter. In addition to describing a 16-day family vacation in England, the letter concludes with, "Back home, Jack never considered controlling lighter-than-air craft with microcomputers until he joined T.C.O.M. Now he's been dodging pigeons

which insist on roosting overhead in their Elizabeth City, N. C., flight test facility — the largest wooden building in the world — an old dirigible hanger where they inflate and test-fly those huge aerostats which will hoist microwave telephone repeaters and TV transmitters into the skies of Nigeria. It's nice to feel that your work is extending modern communications in a developing country."

I hope spring is emerging joyfully as you read these notes. Best wishes to all. — **Frank T. Hulswit**, Secretary and 30th Reunion Chairman, 77 Temple Rd., Concord, Mass. 01742

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R. Stanley Bair was elected President-Elect of the Construction Specifications Institute to serve fron July 1, 1977, to June 30, 1978; he will be President of the Institute from July 1, 1978, to June 30, 1979.

On October 19, Dr. **John J. Schmertmann**, Professor of Civil Engineering at the University of Florida, Gainesville, received the A.S.C.E. State-of-the-Art of Civil Engineering from the American Society of Civil Engineers. Dr. Schmertmann received this award for his paper, "Measurement of In Situ Shear Strength," published by the Society. This is the third national A.S.C.E. prize to be claimed by Professor Schmertmann, who for the past 20 years has been a civil engineering professor at the University of Florida at Gainesville. An author of some 50 reports and papers, Dr.Schmertmann is an active lecturer and consultant (in the U.S. and abroad) in the field of geotechnical engineering. His important contributions in the area of settlement predictions in both clay and sand have helped to advance the profession. Currently he is exploring the advantages of in situ testing, including the reintroduction of the static cone penetration test into the U.S. (in 1965).

We regret to announce the death of **J. M. (Mike) Carney**, who died on June 12, 1977. Mike was Head Engineering Service and technical editor, American Plywood Association, and a prominent structual engineer. Active in professional societies relating to his work, Mr. Carney served as Vice President and President of the Southwest Chapter, Structural Engineers Association of Washington; as Secretary-Treasurer, Tacoma Chapter, National Society of Professional Engineers; a member of the American Society of Civil Engineers; and a member of the Society of Technical Writers and Publishers. He was the author of 16 technical papers relating to engineering and plywood design. Mr. Carney was a licensed structural engineer in Washington and Colorado. He is survived by his wife Susan and son Bruce, both of Gig Harbor, Wash., and two brothers, James and Joseph, both of Connecticut.

Dr. **Juan Navia** is presently Senior Scientist at the University of Alabama in Birmingham's Institute of Dental Research. . . . **Edward R. Adelson** has been elected Vice President of Operations of Aeronautical Radio, Inc., a national airline telecommunications firm. Ed formerly served as Director of International Programs for Martin Marietta Aerospace of Orlando, Fla. He is a member of both the American Institute of Aeronautics and Astronautics and the Society of Logistics Engineers. . . . **Mariano A. Romaguera** would like to be remembered to all.

Gabriel N. Stilian is President of the Advance America Foundation. A.A.F. is the first grassroots public-interest group supported by corporate executives. The mission is to advance the quality of life of the citizenry by advancing the management of America's free-enterprise institutions. Anyone interested in details can write to Gabe. . . . **Tom R. Eggert** moved to Denver seven years ago and became a real estate broker. He now works independently in all phases of real estate. In 1976 he was elected an Arapahoe County Commissioner on the Republican ticket. Arapahoe is just south of Denver and growing 14 per cent per year. The Eggerts are empty nesters now and, except for Christmas, would welcome M.I.T. travelers. Tom is active with the local alumni.

Three members of the M.I.T. faculty have been honored by the American Society of Mechanical Engineers (A.S.M.E.) at its annual winter meeting in November of 1977. Among these was Dr. **Robert W. Mann**, Whitaker Professor of Biomedical Engineering. He was awarded the Society Medal for "eminently distinguished engineering achievement." — **John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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Along with the snowflakes of Boston's biggest January storm come a few news notes. One might wish that the news notes might be as numerous as the snowflakes, or perhaps, after having shoveled the driveway, that the snowflakes were as few as the news notes.

Nick Haritatos writes, "Last spring I spent two delightful weeks in Frankfurt on a chemical project. Then in June I took my family on their first trip to New York and Boston. We all had a superb time at the 25th Reunion. This fall I'm still a cub scout den leader and treasurer. I am also teaching a ninth-grade Sunday school class." . . . **John Gaylord** notes that he is employed by R.C.A. Laboratories in Princeton, N.J., and is responsible for developing computer-based manufacturing systems for solid-state device manufacturing. John is active in the Princeton M.I.T. alumni club. He is married and has three children, two now in college. . . . Mrs. **Josephine von Hippel** is engaged in the practice of psychotherapy and psychosomatic medicine in Eugene, Ore. Josephine is married to **Peter von Hippel**, also of our class, who is Professor of Chemistry at the University of Oregon and Director of its Molecular Biology Institute.

A new graduate of the U.S. Army War College (1976) is **Dick Lyle**. Dick celebrated by touring Peru, Boliva, and Chile on his own in December and January, using native transportation most of the way. Dick recently learned that he had been selected for promotion to full Colonel effective June 2, 1978. . . . The Deputy Director of the Office of Atmospheric Services, National Oceanic and Atmospheric Administration for the past year has been **Daniel Lufkin**. Dan writes that the worst part of the job is being held personally responsible for the shortcomings of the weather, as well as for those of the Weather Service. The best part is the chance to read and answer the rich variety of letters he gets from citizens who have discovered new and marvelous ways of forecasting. On the side Dan has a busy consulting business in solar energy design and is Assistant Professor of Astronomy at Hood College. He also does freelance writing and translating. . . . **Jim Davidson** continues his successful management consulting firm, James W. Davidson Co., Inc., 415 Madison Ave., New York. Jim and his staff of two are active in consulting on company strategy, management improvement, organization, planning and management controls, executive search, screening and selection and acquistions. His list of clients includes such industries as American Can, Ciba-Geigy, International Minerals & Chemical and Raytheon.

Donald W. Coakley has been appointed vice president-controller of United Technologies' Hamilton Standard Division. Donald will direct the division's central financial activities. Don has been division controller since 1976. He joined Hamilton Standard as a test engineer following his graduation in 1952. He has also been contracts and program manager of the aircraft systems department and division assistant controller. Don also has an M.B.A. from Western New England College. — **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741; **Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif. 94301

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Dear 1953ers: First, bits and pieces of news. Our 25th reunion planning is well underway and, according to **Dick Lindstrom**, zillions of you have indicated your intention to attend. (Remember, it's June 8 through June 11.) There is plenty of time for the rest of you to get on board. . . . **Paul Shepherd** apparently has decided that — after more than 20 years with Cabot, Cabot & Forbes — changing jobs can be fun (or is it lucrative?). He left C.C.F., joined another firm for a short spell and now has formed Paul Shepherd & Associates, a commercial and industrial real estate firm in Daly City. . . . **Sid Hess**, according to Grayce, has been traveling back and forth to England often. In July he presided at the Institute of Management Science meeting in Greece — accompanied by Grayce and the children for a two-week tour. . . . **Alvin Pierce** is currently a professor in the School of Aerospace Engineering at Georgia Tech, and busily teaching and conducting research in the fields of aeroelasticity, unsteady aerodynamics and structural dynamics. [*Ed.* I presume that the second field has to do with the problem of overdrinking while flying.]

Mike Rabins, following a two-year tour of duty as Director of the Program of University Research at the U.S. Department of Transportation, has joined Wayne State University as Chairman of Mechanical Engineering. [*Ed.* Mike, you *are* a glutton for punishment!] . . . Recently, **Bruce Beckley** — who is manager of Nuclear Projects for the Public Service Co. (in Nashua, N.H., I presume) — was the guest speaker at the Nashua Chamber of Commerce; his talk was focused on the financial aspects of the Seabrook Station. . . . **Stanley Bloom** is presently Vice President and Associate Director of Research at Polaroid Corporation. . . . **Eric Schwarz** has been promoted to the position of Senior Development Scientist with Union Carbide's Chemicals and Plastics Research and Development Department at Tarrytown, N.Y.; Eric has been with Union Carbide since 1954 and is co-inventor of the "mechanically frothed urethance (sic?) foam concept," as well as author of many scientific papers and patents.

Finally, and unhappily, I must report on two other items. **Bernard Paiewonsky** wrote that "after a long and valiant struggle with ALS (amyotropic lateral sclerosis), Sabina Paiewonsky died on August 30, 1977." . . . **Elmo Pacini** died in late October at the Charles Dana Cancer Center in Boston after a long illness. He had been a system product manager for Dynamics Research Corp. and during the Korean War served as a captain in the U.S. Army. Also, from 1968 to 1969 he was national president of the Institute of Environmental Sciences.

June is fast coming, thus please keep my mail bag full so that I may end this "tour of duty" as secretary in a blaze of newsprint. — **Martin Wohl**, Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

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Robert Mackintosh recently retired from the U.S. Army and is working for Planning Research Corp. in Huntsville, Ala. . . . **Scott Mudgett** retired from the Army in 1970 and then attended M.I.T.'s Sloan School. He is now a vice president of a $400 million New York Metropolitian area retailer with a home on Roosevelt Island (in the East River between Manhattan and Queens). Scott writes: "Barbara waves goodbye as I take our Bell 202 B (helicopter) to visit our stores while Victoria schools at Purdue, John prepares for Tech, and Felicity for Radcliffe. Boy, what a life. Thanks M.I.T. and M.I.T. Sloan!" We're always happy to hear from satisfied customers, Scott.

Last fall, **John Preschlack** was appointed President of the General Binding Corporation in Northbrook, Ill. John, Lynn, and their three boys have "settled into Lake Forest and are very happy with their new environment." General Binding is a worldwide manufacturer of office and graphic arts equipment to which John brings over four years of experience as President of ITEK's Graphic Products Division. . . . **Paul Gray** addressed business and civic leaders in Atlanta, Ga., in November. Co-chairmen for the meeting were Techmen Milt Bevington, '49, and **Tom Wilbanis**, S.M. '54, Chairman of the Board of the First National Bank of Atlanta. Paul spoke on M.I.T.'s relation-

ships with industry over the past century including it's training for future leadership roles in industry and business. Tom provided a perfect example, being a Sloan Fellow who received his S.M. degree in '54. **Jim Rude** recently became a Life Master in the American Contract Bridge League. — **Dave Howes**, Secretary, Box 66, Carlisle, Mass. 01741; Assistant Secretaries: **Lou Mahoney**, 6 Danby Rd., Stoneham, Mass. 02180; and **Chuck Masison**, 76 Spellman Rd., Westwood, Mass. 02190

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Another spring, and with it come the plans for activities in the warmer months. One of the items you should warm to is our 25th Reunion, coming up fast in 1980. Maybe if I start reminding you now, you'll be sure to plan for it.

On December 15, 1977, Dr. **Robert Madey** was elected Vice President of Development of Grumman Energy Systems, Inc., a new wholly-owned subsidiary of Grumman Corp. He joined Grumman in 1963 as head of the Nuclear and Space Sciences programs where he was involved in managing scientific projects for N.A.S.A. In November, 1977, Dr. Madey was issued a patent for a new type of evacuated-tube solar collector for generating high temperatures suitable for industrial process applications. Bob lives with his wife Gloria at 7 Milford Ln., Huntington Station. They have three children: Robert, 15, Michelle, 14, and Donna, 11.

Richard I. Bergman has been appointed as executive director of the newly-formed federal Interagency Task Force on Workplace Safety and Health. He begins his new duties immediately and will direct the Task Force's activities in exploring incentives that might supplement workplace safety regulations; evaluating government-wide administration of federal workplace safety and health activities; and reviewing other ways to improve safety and health efforts of all federal agencies. From 1960 to 1967, Bergman was director of engineering and development at Princeton Chemical Research, Inc. Since 1967 he headed both the research and development program and consulting division of Systemedics, Inc., Princeton, N.J., where he directed projects in such areas as health care systems development, medical information systems, health care policy analysis, problem oriented medical records systems and physician surveys on such topics as product-related accidental injuries and hypertension. He is a member of the American Public Health Association, Sigma Xi, American Assoication for the Advancement of Science, American Institute of Chemical Engineers and American Chemical Society.

Gary Brooks has returned to the management consulting profession, opening an office in Longmeadow, Mass. He also works in affiliation with the Pace Consulting Group of Hartford, with most activity focused on New England clients. . . . Last summer **William D. Chandler** left Potlatch Corp. in Arkansas, and relocated in Pueblo, Colo., where he established his own management consulting firm, Chandler Associates, Inc. Bill felt he needed some excitement in life, now that two of his youngsters are in college (Northwestern and U. Colo. - Boulder) and the third is in high school. He reports that life now is indeed exciting.

Ralph L. Wanger, Jr. became president of the Acorn Fund, Inc. last year. He had previously been executive vice president of the fund. Ralph reports with some pride that the $42 million no-load fund quadrupled in size the last three years, no doudt because its net asset,value was up 62 per cent in 1976 and 15 per cent in 1977. . . . **John Dixon** was elected a Fellow of the American Institute of Architects, receiving its medal at the A.I.A. convention in San Diego last June. He has completed six years as editor of *Progressive Architecture*, which is doing well. His wife Carol is chairwoman of visual and performing arts at Greenwich (Conn.) Academy. Son Peter enters college in the fall, when daughter Susannah starts high school. . . . **Philip A. Untersee** and his wife Mary have been involved in presenting marriage encounter weekends for the past three years. They heartily recommend the experience for any couple who wish to deepen and enrich their relationship.

A sad item to report is the death of **John Hartnett** on December 23, 1977. Our sympathies go to his family. — Class Co-Secretaries: **Allan C.Schell**, 19 Wedgemere Ave., Winchester, Mass. 01890; **Marc S. Gross**, 3 Franklin Ct., Ardsley, N.Y. 10502

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Harvey Levine has been appointed General Manager of the Industrial Precipitator Division of

Harvey Levine, '56

Research Cottrell, a leading air pollution control equipment manufacturer. . . . **Bruce Montgomery** has been appointed an associate director of the National Magnet Laboratory at M.I.T. Bruce has been leader of the Magnet Research and Technology Group for the last 14 years and will now be responsible for high field magnets and fusion machines, all tied to government research. . . . **Larry Moss** writes that he is chairman of the environmental caucus of the National Coal Policy Project. Industry and environmentalists are trying to work out a compromise on the use of coal. (After receiving this note, the February issue of *Fortune* came in the mail with Larry and the N.C.P.P. as one of the feature articles.) We hope this group comes up with some positive results considering the key role coal is likely to play in the economic future of our country. . . . **Robert Scher** has been appointed Vice President of Engineering of Teledyne Gurley, responsible for design and development of new products as well as engineering and technical requirements of production. Teledyne Gurley is a manufacturer of electro-optical encoders, digital readout systems, surveying instruments, hydrological and meteorological instruments.

David Shefrin sent us a catalogue and some student newsletters from his Computer Processing Institute in East Hartford, Conn. Dave is President of the educational Institute as well as its parent, Northeast Computer Systems. It would appear Dave is an important supplier of trained computer operators to Connecticut business. . . . **Rosemarie Wahl Synek** writes she is now Associate Professor of Biology at St. Mary's University of San Antonio, Tex. . . . **Victor Vaughen** writes that he was married to Salli Kimberly last June. His work at Oak Ridge includes studies of Nuclear Fuel Reprocessing. . . . **Stan Wray** writes that his son, Stan III, entered M.I.T. last fall from Norbonne High School in Lomita, Calif. After a life in the Long Beach area, this winter in Boston must be traumatic. Stan and Marie ('59) both work as computer programmers at the Aerospace Corporation in El Segundo.

It hardly seems like the Christmas Season has occurred until I read the annual letters from the **Colemans** and the **Manspergers**. Over the years, these annual updates certainly give me some understanding for the meaning of family where parents and children share fully in each others lives. **John Coleman** continues his efforts to develop a hydrofoil for Boeing, but church, family and friends (and soccer games) provide a fullness. **Bob Mansperger** spent a good part of the year distracted from his normal pattern after the family sustained a damaging fire in their home in Euclid. Well, let us hope all have a good start on the new year. — Co-secretaries: **Bruce B. Bredehoft**, 7100 Lanham Ln., Edina, Minn. 55435; **Warren G. Briggs**, Northeastern University, Deree College, Box 472, Athens, Greece (until July).

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Avast ye hearties! Set your sights for the 20th class reunion on Martha's Vineyard at the Harbor View. Great treasures of good fun await you on June 8 to 11. Captain **Frank Tahmoush** and his stalwart reunion committee crew are armed to the teeth with activities to keep you groggy and gratified.

First on the horizon is Tech Night at the Pops on Thursday night, June 8. We'll all have reserved tables together at Pops and then rendezvous afterward for an elegant wine and cheese party at the nearby townhouse of **Mike Brose**. Even if you can't make the reunion, be sure to come to Pops and the party. Take an extra day off — you deserve it after 20 years. Besides, free dormitory housing is available at M.I.T. on Thursday night for those attending Technology Day on Friday or attending the reunion. So, follow the logic of incremental pricing and start the reunion on Thursday.

Next in view is the spray-swept ferry-boat ride to the Vineyard, then onward to the lighthouse marking the picturesque Harbor View Hotel. Renew acquaintainces during dinner and entertainment on Friday evening. But get a rest because Saturday is the big day for sailing, bike riding, tennis, the mini-marathon, swimming and sunning by the heated pool, drifting through the dunes, and browsing along the quaint streets and shops of Edgartown. Unwind again that evening at the Candlelight dinner followed by, for the energetic and able-bodied, dancing till the wee hours. Revive on Sunday with the fabulous Harbor View Shore Dinner, a specialite du maison. All in all, this reunion promises to be a memorable occasion. Early returns show that more of your classmates than ever will be there.

Join us. Send in your reservation form now. Remember, your class dues are needed to help with the Reunion Questionnaire printing and processing, and with the mailings to all the class members. Therefore, if you're quavering for quinquennial questionnaire quanitification, quickly send your class dues of $12 to: **Steve Hadjiyannis**, Reunion Treasurer, 127 Long Hill Rd., Franklin, Mass. 02038.

Other news this month comes from many quarters, including that "other" island of Nantucket where **Carl Borchert**, his wife and two children have been living since 1969. As Carl relates, "I left the military-industrial complex for the simple life. Now I am a self-employed builder and part-time engineer (structures and sewers) while Karen teaches kindergarten." . . . **Toby Carlson** is still living in State College, Penn., and teaches meteorology at Penn State University. He and his wife wrote us that "we just finished our fourth consecutive year in the annual madrigal dinner production where we perform as strolling musicians."

Frederick John Page, who started M.I.T. with the Class of '58, but finished later, will be remembered by many of you. John is now a consultant with Technology Consulting Group in Boston where he has been working on assignments for U.S. and international firms, particularly Swedish concerns. John is an active participant in Renaissance festivals and re-creations of the period. He is also teaching courses at the Cambridge Center for Adult Education on the subjects of the creative uses of fantasy and personal planning techniques.

Earlier this year, **Herbert Waxman** was named Chairman of the department of medicine of Baystate Medical Center. Previously, he was Deputy Chairman of the department of medicine at Temple University. His principal areas of specialty are internal medicine and hematology, and he has conducted extensive research on sickle cell anemia and other disorders. In his new post, he will direct the four-year graduate education program in clinical medicine. Herbert, his wife and

three children are now living in Longmeadow, Mass. . . . **Thomas Reed** is a division leader at the Draper Lab in Cambridge and lives in Sudbury. . . . **Sheldon Buck** has taken up the country life and moved to Medfield, Mass., where there is space for the newest member of their family, a thoroughbred named Slim. Sheldon notes that "my wife Dee-Dee has taken up her old hobby of riding and we recently purchased a horse. Our son Stephen is active and fine, and will enjoy the country."

Congratulations to **Daryl Wyckoff**, who told me that in January he was promoted to full professor with tenure at the Harvard Business School. His newest book, *The Domestic Airline Industry*, was published this past year by Lexington Books. . . . A brief letter from **Daniel Brand** tells us that "I've left my position as Undersecretary of the Massachusetts Department of Transportation to join the consulting firm of Charles River Associates in Cambridge, where I'll be working in all phases of transportation planning." . . . **Ed Newton** closes out this month's mailbag with this word: "I have just been promoted to General Manager of G.T.I. Clover Division. We are looking forward to the reunion in June on Martha's Vineyard." Well, what more can we say? — **Michael E. Brose**, Secretary, 30 Dartmouth St., Boston. Mass. 02116

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As these class notes are assembled, the snow is turning to slush, there is local flooding, and I realize that in moving south from Massachusetts, I did not quite make it to the Sun Belt. Ah, but one of our number did. Over dinner in New Orleans last month, **Jason Speyer**, who moved to the University of Texas at Austin from Winchester (*not* Lexington, as reported earlier), championed the virtues of the Great Southwest. His only pejorative comment: most of the neighbors have New York or New Jersey accents. Jason recently was named an associate editor of the American Institute of Aeronautics and Astronautics' *Journal of Guidance and Control*. . . . Still out there in the Diaspora is **Mike Padlipsky**, who reports, "Status is as quo as ever: still living in Burlington; still working in Bedford; still thinking it's too far to Cambridge."

And just across the river, Boston's Camp, Dresser, and McKee announces that **Walt Niessen** has been named vice president of the industrial engineering division. Walt lives in Andover with his wife, Dorothy, and their children, Heidi and April. He is a registered professional engineer, a member of the American Institute of Chemical Engineering and of the American Society of Mechanical Engineers, and a diplomat of the American Academy of Environmental Engineers.

John Hartung is serving as president and CEO of Rayonier Quebec along with his duties as senior vice president of operations for ITT Rayonier. . . . **Gerald Hurst** is spending a sabbatical year after over two years as chairman of the Department of Decision Sciences at the Wharton School. . . . **Harold Levy** has joined Applicon, Inc. of Burlington, Mass., where he is developing computeraided design systems for the integrated circuit industry. . . . After "15 happy, hectic, and rewarding years" as a civilian Air Force employee, **Cyril Pierce** has joined the General Electric Company's Aircraft Engine Group. Cy's last government position was director of manufacturing for the F-16 program office, and he is now manager of G.E.'s Manufacturing Technology Laboratory. . . . **Clarence "Cause" Kemper** has completed a three-year tour of duty as deputy chief of staff, intelligence for the United States Commander, Berlin, and he has been assigned to the U.S. Army Intelligence and Security Command office in New York. . . . **Lawrence Kravitz** writes from Maryland that he is participating in the test, design, and evaluation of the Army's new XMI tank. . . . **John Windle** is Vice President of State Street Consultants and proprietor of Ahmed's, a French-Moroccan restaurant, bar, and disco in Harvard Square. . . . **Tom Alexander** reports from Santa Monica that he still is engaged in computer programming.

To continue our search for missing alumni, please write if you know the whereabouts of any of the following: **LaDage**,**Lamport**, **Lauzar**, **Lavin**, **Lee**, **Lewin**, **Lifshitz**, **Litton**, **Martin**, **McLaughlin**, **Mehrtens**, **Moore**, **Moschoyakis**, **Munzner**, **Nelson**, **North**, **O'Brien**, **Pack**, **Parmley**, and **Perrin**.

We're down to "T minus two years and counting" on our 20th reunion. Let's hear some of your thoughts on what you'd like the reunion to be, where it should be held, and so on. — **Robert F. Stengel**, Secretary, 329 Prospect Ave., Princeton, N.J. 08540

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First of all I would like to start off this column with an apology to **Tony Silvestri**. The December column, because of an apparent typographical error, seemed to say that Tony lived *alone* with three sons. I meant it to say that he lived *along* with three sons and his wife, Teri, in San Jose, Calif. I am very sorry for the confusion this probably has caused him and his wife.

I got a very pleasant letter from **Bill Jouris**. He enclosed his annual Christmas letter and suggested that other class members might send their letters to me as well. It would be a painless way to keep your 'mates informed of your doings. I think it's a wonderful idea, Bill, and will try to mention it around Christmas time. Bill reports that he traveled back to the U.S. from Riyadh, Saudi Arabia (where he is at the King Faisal Specialist Hospital and Research Center) via New Zealand last summer. The "problem with visiting two hemispheres in a single trip is that you have to carry clothing for both summer and winter," reports Bill. The other major bit of news for the Jouris' this year was the tonsilectomies in both of their first-grade twins, Brian and Lisa. Bill reports that he has seen *Star Wars* four times and that their Saudi Halloween consisted of dressing up as Princess Leia, a Jawa, Darth Vader and R2-D2. Sounds just like a Chestnut Hill, Mass., Halloween! Bill also mentioned that he had heard from **Jim Clayson** a year ago. Jim has been living in Paris for several years and runs his own consulting firm out of his apartment. He commutes between Paris and London where he is working on a Ph.D. in African economics. Thank you, Bill, for the news.

Some other notes came during the last month, for which we are most grateful. **Terry Langendoen** wrote that he has returned to his duties as Professor and Executive Officer of the Ph.D. program in Linguistics at the Graduate Center of the City University of New York, after spending the spring of 1977 as a Fulbright Lecturer at the Institute of General Linguistics, State University of Utrecht in the Netherlands. . . . **John Layter** wrote that he is still doing high-energy physics for the Unversity of California at Riverside. But he has been traveling. He spent three years at C.E.R.N. in Geneva and now spends a lot of his time at Berkeley building elements for a time projection chamber which is a detector that will be used at the P.E.P facility at the Stanford Linear Accelerator.

Bob Mroczkowski writes that he is now the manager of metallurgy and materials processing and the acting manager of polymer engineering for A.M.P., Inc. He says that he is not sure how the polymer jobs came about and that although he likes administration he misses getting his hands wet. . . . Finally, **Andy Zeger** writes that after 12 years working for General Atronics/Magnavox (where he was Manager of the Adaptive Systems Division), he quit and started up his own firm: Zeger-Abrams, Inc. It's a consulting firm. Good luck, Andy, and thanks to all of you who have written to keep us up to date. — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

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Frank Rubin has published a number of articles on various aspects of combinatorial mathematics, is a member of the Jewish Welfare Board, the Community Relations Council, and president of the local district of the Zionist Organization of America. . . . **Harold J. Metcalf** is on sabbatical from Stony Brook to M.I.T. He enjoyed visiting the Institute and seeing it in a new light. Marilyn and David, Cindy and Jonathan are all o.k. . . . **Roger M. Rowe** changed employment in November. He is now working for a communications and computer technology consulting firm, and is manager of a microcomputer laboratory for developing systems applications. Wife Suanne and three children live in Rockville, Md. . . . **Lynn W. Whelchel, Jr.** is still practicing active general surgery.

Dr. **David H. R. Vilkomerson** is now Director of Research of the Special Research Group of Johnson and Johnson working on advanced acoustical imaging systems for medical diagnostic use. . . . **Philip S. Schmidt** is still Associate Professor of Mechanical Engineering at University of Texas. Active in research in areas of industrial energy conservation, he has also formed a consulting firm, Energy Engineering Associates, specializing in energy conservation projects in industry and commercial buildings. . . . **Winn Martin** recently left Price Watershouse and Co. to enter a small family business in Clayton, Ala. . . . **David R. Spencer** has been promoted to President of Datalog Division of Litton Systems last April. His wife, Dr. Pamela J. Spencer, is a psychologist at the Farmingdale campus of S.U.N.Y. Sons Marc and Scott are now 7 and 3.

Elliott J. Bayly is entering the Wind System Manufacturing and Consulting Business. . . . **David Stare** is the winemaker at Dry Creek Winery, Healdsburg, Calif., a small but classy winery in the Sonoma Valley. . . . **Donald C. Fraser** of the Charles Stark Draper Lab will be giving editorial guidance to A.I.A.A. on the bimonthly *Journal of Guidance and Control*.

Modesto Alex Maidique is at the Harvard Business School doing research on solar energy and will be co-authoring a book, *Coming to Terms with our Energy Dilemma*, to be published by Random House this summer. He is also teaching and doing research on technological innovation. . . . **Barrett B. Roach** has joined Shaklee Corp. as Vice President, Corporate Development, in charge of planning, strategy, diversification and acquisitions. — **Gerald L. Katell**, Secretary, 7 Silverbit Ln., Rolling Hills Estates, Calif. 90274

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This month's deadline finds your class secretary on the road. While my family and all my sane friends are warm and comfortable in California, I am trotting around the frigid east — to places like Chicago, Detroit and Pittsburgh.

Pretty good crop of notes this month. You are really coming through for the alumni fund and, incidentally, for me. I can always count on some news from **Ed Dudewicz**, who writes that he was promoted to Professor of Statistics at Ohio State as of September, 1977. Ed was also elected a fellow of the New York Academy of Sciences. He received the 1977 Research Award of the Ohio State Chapter of the Society of the Sigma Xi for "outstanding achievement in scientific research." The award includes a plaque and a $200 honorarium. . . . Another regular in this spot is **Henry Nau**, who is teaching full time at George Washington University and part time (one day a week) at Columbia University. Henry spent a year and a half with the State Department and a semester as a Visiting Professor at Stanford. His current research deals with U.S. foreign policy in the energy and food crises. . . . **John Shuck** recently joined the faculty of Ursinus College near Philadelphia as Assistant Professor of Mathematics. John had spent the previous seven years on the faculty at the University of Rochester.

After graduation from M.I.T. and Yale Medical School, **Stephen Miller** married Christina Gilbert. The Millers are parents of an 8-year-old son. Stephen is on the faculty of Harvard Medical School and is in the cardiac radiology section of Mass. General Hospital. . . . Sharon and **Josef Nathanson** welcomed the arrival of their daughter, Amy Miriam, September 20, 1977. For the past year Joe, an urban planner/regional economist, has been technical director for an economic devel-

opment program in Baltimore. Sharon (U.C.-Berkeley, '68) also worked as a planner for social service programs for Maryland's Department of Human Resources.

Brian Strong and his wife Nancy and children Robbie, 8, Kevin, 7, and Dara, 4, have been in Tokyo since August, 1976. As manager of marketing services for World Trade Corp. (I.B.M.), Brian is concentrating on long-range marketing strategy in Japan. The Strongs are enjoying the skiing and sailing in Japan. They invite anyone in Tokyo to give them a call. . . . There have been unusual developments of careers for some classmates. **Mike Fitzpatrick** has a radio program on New York's WNYE (1440 AM). His 4:00 p.m. Saturday show is called "The Word." . . . **Lewis Neuman** is dealing in art, specializing in work by contemporary Russian sculptors and painters. . . . **Bob Yaes** is still an unemployed physicist living in Newfoundland.

Finally, **Marvin Singer** sent me a Christmas card via the Alumni Association. Marvin and Karen now have two sons — Robby arrived last March. Marvin has been inducted into the Department of Energy. He reports that the major difference between his current job and his previous one is an increase in taxi utilization as he whizzes around to meetings all over Washington. Regards from all the Bertins to all the Singers. And to all of you. More next month. See you at the reunion in June. — **Mike Bertin**, Secretary, 18022 Gillman St., Irvine, Calif. 92715

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Keep it up classmates! It was great to receive so many envelopes full of your news. Now you'll be able to hear of your fellow classmates, not just your class secretary.

Dr. **Markham Alpert** is a visiting professor of business at the University of Pittsburgh until August, 1978. His wife Judy is completing her doctoral dissertation in music education. . . . The **Michael Auerbach** family are now in their new home in Waterford, Conn., and Mike is working at Pfezer, Inc.

And on the other coast, the state of Washington to be exact, resides **John Carlin**. He is a C.P.A. working for the state with a small practice of his own on the side. John is divorced, living in Olympia with his cat, and climbing mountains for a hobby.

Two of our classmates have written to announce new additions to their families. The **John Ludutsky**'s are now the proud parents of their first child — a girl, Dana, born November 16, 1977, weighing 6 lbs. 13 oz. . . . Rena, Debra and **Maury Shulman** are proud to announce the birth of Debra's brother Andrew Ira on October 17, 1977. May you all have many years of joy from those new members of your families.

Just a few words of wisdom from **Richard T. Murray** — "like many others a victim of the high cost of low living." . . . **Jack Prosek** moved to California in June of last year after 12 years in the Chicago area. He was transferred by Turner Construction Co. to their San Francisco office. At the present time, Jack is Project Engineer for a Float Glass Plant in Fresno and an electronics manufacturing facility in Santa Rosa.

Peter Shaw received his Ph.D. from Stanford in 1968. He is presently doing research on public opinion for Benson and Benson, Inc., of Princeton, N.J. . . . **Bill Young** was recently promoted to Vice President at the New York based investment banking firm of Morgan Stanley and Co. He is a securities analyst for the chemical industry and was named to the Second Team of the Institutional Investor All-American Research Team in 1976 and 1977.

Another bit of class news came via a newspaper clipping. It was announced that **Lawrence Seligman** has been appointed director of small business systems development for Data General Corp. of Westboro, Mass. He was formerly head of the systems products organization at Data General where he has been employed since 1969.

We saved a few envelopes for next month in case we aren't as blessed with news as we were this time. So if you missed your name in print, read the column next month. And for those who haven't written — WRITE!! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

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This month's mailbag brought lots of Alumni Fund envelopes with news, so the winter's drought seems to have ended. **George Lee** is working for T.R.W. in Los Angeles; George and wife Susan have two daughters, ages 3 and 1. Diane and **Michael Keehner** are still in New York, where Michael is a Vice President of Kidder, Peabody and Co., and Director at Inexco Oil Co. At the time of writing, a second child was "imminent." . . . Last year was a big one for **Peter Sexton**; he started in May as Manager of New Product Development at Handy and Harmon, Fairfield, Conn., and the Sextons had their first child, Alissa, on July 19. The Sextons now live in Newtown, Conn. . . . **Bernard Nordmann** has changed jobs and is now working for Conrac Corp. in New Jersey; previous jobs have taken him to the U.S.S.R. and Ireland, but no travel this year.

Someone who will be traveling is **Pierre Perrolle**, who just started as a staff officer and professional associate of the Academy of Sciences' Committee on Scholarly Communication with the People's Republic of China, promoting scientific and scholarly exchanges between the U. S. and China. Pierre will be based in Washington and making occasional trips to China. . . . Also traveling is **Steve Lipner**, our former class secretary. Steve is in Neubrucke, Germany, running a small MITRE field office on an Air Force project. . . . **Sharon Ross** attended an A.A.A.S.-sponsored conference on women in scientific research, studying problems encountered by women scientists, to make recommendations to congressional and funding agencies.

Gail and **Edward Bucher** were the proud parents of a daughter, Sabina Lee, on November 26, 1976. **Jeff Karas** has been promoted to Systems Supervisor of Technical Support Systems at Honeywell Information Services in McLean, Va. His wife, Regina, has been licensed in Maryland as a certified social worker. . . . **Frederick Stegeman** is an architect and general contractor in California; he practices as an owner's representative on major building projects.

Kathy and **Stanley Brown** received nine-month appointments at the Swiss Research Institute for Experimental Surgery and the Straumann Institute of Engineering. They are spending December, 1977, through September, 1978, studying allergic reactions to metallic implants at the Research Institute, which is in Davos, Switzerland. I hope they are both avid skiers! . . . **Neil Lupton** is Industry Manager for Packaging and for Government Sales in the Nylon Resin Group at Allied Chemical in Morristown, N.J. Neil's wife, Claire, is in the advertising department at Keuffel and Esser. . . . Carolyn and **John Golden** and their four children are living in Summit, N.J., where John is Director of Corporate Information Processing for the Schering Plough Corp.

Finally, we must note the death of **Wendell Bridges**.

This column is simple when you write. See you again in the spring! — **Edward P. Hoffer**, M.D., Secretary, 12 Upland Rd., Wellesley, Mass. 02181

66

We've received tons of mail to start the New Year right.

First off, **John Dawson** and wife Cheryl, a '67 M.I.T. grad, have been living in York, Penn. John joined the faculty at Penn State in 1975 after obtaining his Ph.D. at the University of Michigan. They share a number of mutual interests including number one and number two flute positions with the York Symphony Orchestra, gourmet cooking (specializing in Chinese), photography, traveling and birdwatching. They maintain contacts with many college friends and frequently visit M.I.T. for reunions.

Richard T. Cockerill and wife Becky are pleased to announce the birth of their first child, Kristin Coline, on August 8, 1977. Richard has been with the Navy Department in Washington, D.C., for the past ten years. . . . **Joseph Adolph** is practicing urology in Marlboro and Framingtown and is on the educational council for M.I.T. . . . **Lewis B. Jackson, Jr.**, writes that he plans to start a consulting business in January.

Dr. **Hans C. Jurkam-Wold** is now living in Denver, Colo. He is Director of Special Projects with Gulf Mineral Resources. He enjoys skiing, hiking and other outdoor sports. . . . **Robert Poole** is President of the Local Government Center, a non-profit research organization based in Santa Barbara. His "Fiscal Watchdog" column appears monthly in 150 newpapers. He is also working on his second book, tentatively titled *Cutting Back City Hall* which is scheduled for publication by New York's Free Life Editions in the fall of 1978.

Jeffrey Levine, his wife Diane, daughter Alison (1 year old) and son David (4 years old) live in Lexington, Mass. After Jeffrey got his Ph.D. in physics in 1971 from M.I.T. he worked as a staff member in Lincoln Lab Optics Division until January, 1976, when he co-founded Lazer Development Corp. in Lexington. L.D.C. develops advanced laser systems for several government agencies. . . . **Paul G. Godfrey** settled in southern California about a year ago where he joined a practice with 14 other M.D.s. He, his wife, and daughter Kelly who is two and a half, love it there. He saw **Dave Anderson**'s son, Wiley, a few months ago.

Tom Grover is the proud father of Rebekah Katherine, born May 23, 1977. . . . Dr. **Rodger Thompson** is group leader of the University of Arizona's Steward Observatory, currently studying the formation of the star known as M.W.C. 349 through their 90-inch reflector telescope. He is also a member of the team planning the infrared telescope for one of the N.A.S.A. Space Shuttles. He continues his research and teaching at the Steward Observatory and the University of Arizona. He and his wife Jennifer have two children, Michael (6) and Heather (4).

Maurice H. Stauffer is now living in Wayland and on January 11, 1977, fathered Samuel Maurice. . . . **Phil Perkins** is working long hours at L.T.X. Corp., Newton, Mass., a company which he helped found. The business is just over a year old and makes computer operated test systems.

Richard Gray is now working as an engineer at Millipore Corp., and he moved to Brookline this summer. . . . **Tom McDonough** writes that his N.A.S.A./National Academy of Sciences Resident Research Associateship at Caltech's Jet Propulsion Lab ends on January 1, 1978. He then plans to do a lot of freelance writing and will continue to be a Research Affiliate at J.P.L. . . . **Roger Allen Samuel** received his S.B. degree and his civil engineering degree from M.I.T. and also received the M.S.E. degree in civil engineering from the University of Michigan in 1967. He was appointed an Industrial Liason Officer in the M.I.T. Industrial Liason Program effective October 31, 1977. Prior to his appointment, he was a member of the research staff of the Boeing Commercial Airplane Co. of Seattle, Wash. from 1969-1977.

J. Patterson successfully completed the 26-mile, 385-yard Second Annual Marine Corps Reserve Marathon held November 6, 1977, in Washington, D.C. The course is A.A.U. certified and serves as a qualifier for the Boston Marathon. . . . **Joe Sullivan** has recently been appointed Vice President, Manufacturing, and a director of U.T.Z., Inc., a Hanover, Penn., manufacturer of snack foods and other food items. . . . **Byron C. Gilchrest** was appointed Deputy Secretary of Transportation and Construction, Commonwealth of Massachusetts.

Paul Kebabian writes that he is another year older, but not deeper in debt!. . . . **Peter Lobban** has spent the last year in Palo Alto, Calif., working with Varian Associates researching new uses for microprocessors. His son is now two and a half. . . . **Matt Fichtenbaum** writes that he is still Visiting Assistant Professor in electrical engineering at

Linkoping University until January, 1978, then home to Massachusetts. During his stay in Sweden he not only learned to play their traditional folk instrument, the "nychelharpa" (or keyed fiddle), but built his own.

Jack Fuhrer is now working for R.C.A.'s Consumer Electronics Division in Indianapolis improving R.C.A,'s televisions for 1979. They enjoy Indianapolis, but miss Princeton. . . . **Thomas Hall** received a master's degree in nutrition and bio-chemistry from the University of Connecticut and is now teaching at Technical College in Connecticut. He is now living in Coventry, Conn., and has a 2-year-old daughter Delyn. . . . **Dan Dedrick** is now an instructor in anesthesia at Harvard Medical School and an assistant in anesthesia at Massachusetts General, specializing in Pediatric Anesthesia. . . . Major **James Kester** is still assigned as a systems analyst with Air Force Global Weather Center at Offult A.F.B., Neb. He became a Major on January 1, 1978.

Three members of the class were written up in *Tech Talk* over the past few months. **Monty Graham**, who is an assistant professor at the Sloan School, had a series of photographs on exhibit at the M.I.T. Faculty Club in December. **Ken Browning**'s wife Jane saw the exhibit and found the photographs to be superb. . . . **Stuart Madnick**, also of the Sloan School, was chairman of the Third International Conference on Very Large Data Bases that was held in Tokyo in the fall.

Finally, **Marvin Sirbu** has been doing a fair amount of work on electronic mail. Marv held a series of lectures during I.A.P. discussing his work on "The Office of the Future," including an examination of the political, social, technical and organizational issues raised by office automation. Marv presently is a research associate at the Center for Policy Alternatives at the Institute.

Ken Browning saw **Ralph Schmitt** and **Hank Perritt** in Boston during December and said all goes well with both of them — **Paul Rudovsky**, Secretary, 340 East 64th St., New York, N.Y. 10021

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The arrival of Matthew David Swanson (Class of 1999), aka Tax Exemption, on December 29, 1977, was the happiest moment of your scribe's recent life. What a miracle! Only twins could have been better. Charlotte and Matthew are happy and well.

I received a newspaper article and several photos concerning the life style of John ('66) and **Cheryl Klitzke Dawson**. When John joined the Penn State/York faculty in 1975 as Assistant Professor of Mathematics, the Dawsons brought to their new home a gamut of interests that would lead the most casual observer to conclude that they had lengthened the 24-hour day. John and Cheryl auditioned against each other for the principal flutist spot in the York Symphony Orchestra when they arrived in York, and male chauvinist readers will be pleased to hear that John sits in the number one seat, where he belongs. (Note: This breaks the lengthy string of Class of 1966 defeats in head-to-head competition with our class, including, of course, our freshman year Field Day). Among the Dawsons' interests are extensive traveling, biking, gourmet food (principally Chinese), outdoor photography and mathematics. Cheryl, who also majored in mathematics at M.I.T. and later earned a master's at the University of Washington, teaches part time at Penn State/York. As a member of M.I.T.'s Educational Council, Cheryl interviews prospective students from local high schools.

John Mauer co-authored an article entitled "Electron Optics of an Electron-Beam Lithographic System" in the *IBM Journal of Research and Development*; John is at the IBM System Products Division laboratory in East Fishkill, N.Y. . . . **David Ofsevit** has left the Department of Transportation and accepted a position at MITRE Corp. . . . Lees and **Stephen Stuntz** have moved into a large Victorian house in Acton, Mass.; Steve is Financial Vice President for Daystar Corp., a solar-energy subsidiary of Exxon. . . . At last report **Tim Gill** was planning a long hitchhiking trip to the Southwest to look for a position and a place in which to settle down after years of travel. . . . **Bob Domnitz** has formed Technical Collaborative, Inc., in Lexington, Mass., to provide services and small-scale manufacturing in electronics, acoustics, and bioacoustics. He would be happy to hear from any classmates who are involved in these technical areas.

In addition to his job with TRW, **Mike Zuteck** does structural analysis and design as a consultant to Gougeon Bros. on a project to produce 125-foot wood/epoxy wind turbine blades for the N.A.S.A./D.O.E. 100-kw. generator. He had a busy year as President of the United States Tornado Catamaran Association and is now Secretary of this organization. . . . **Stan Rose** has joined Bankers Trust. His children Stephanie, 4, and Jeffrey 3, are in Montessori. . . . Jill and **Myron Sussman** should have their baby by the time this appears in print. . . . **Michael Rosenblum**, '68, and his wife are still happily working in New York City's garment center. They recently saw **Larry Gottlieb**, who lives in Denver, and had a great Chinese banquet in Chinatown wtih a group of people including Paula and **Jim Foster**. — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

68

Let's lead off this month with a real success story. In January, 1977, **Michael Riordan** published *The Solar Home Book* together with Bruce Anderson, '69, a former roommate and crew partner at M.I.T. In the year since publication, Mike reports, the book has been identified as the best available on solar heating and has sold over 100,000 copies. . . . And from **Arthur Glassman**, another kind of success story eloquent in its simplicity: "Columbia finally gave me my physics Ph.D.!"

A couple of other reports this month from people finishing school. **Walter Oney** writes that he is in his last year at Suffolk Law. He plans to work next year as a law clerk at the Mass. Supreme Judicial Court and look for a job in federal litigation in one of the Boston firms. He was laid off as a programmer last August when his grant money ran out, but on balance, that was a good thing, as being editor of the law review keeps him busy enough these days. . . . We had a visit from **Art Cole**, who was in Washington for a transportation conference. Art returned to school after a stint in the Air Force, and is now completing his Ph. D. at the University of Michigan. He plans to join Ford, where his wife Joanne, '70 now works. He reports that daughter Gwen is now 8 and doing fine.

Other reports from the world of academia are from **Paul Durda**, who is thoroughly enjoying his second stay at M.I.T., this time as a postdoctoral fellow at the M.I.T. Center for Cancer Research. . . . **Carl Martland**, a research associate in the M.I.T. Department of Civil Engineering, is active in the Center for Transportation Studies. . . . **Rich Adelstein** is still an Assistant Professor of Economics at Wesleyan, and with his wife Sandy, is enjoying a beautiful daughter, Rachel Louise, born September 3, 1976. . . . **Alan Baum**, who received his Ph.D. in applied math from Brown University in 1973, has been teaching at the University of Michigan - Dearborn since September, 1972. Alan is now an Associate Professor, and is looking forward to his sabbatical next year. He also reports that he is rapidly approaching his tenth anniversary of marriage to Lonna Broudo, and that his children Julie, 7, and Brian, 4, are both developing mid-western accents.

In a card from Lynda and **Harvey Newman**, we have learned that Harvey recently signed a Foreign Visitor's Contract with D.E.S.Y. and they have moved from Geneva to Hamburg. They expect Daniell, 19 months, to lose his French and pick up German along with them. They will miss the scenery and weather of Switzerland, but are looking forward to new activities in and around Hamburg. . . . Through a letter from Mark Aquino, '72, to his class secretary, Dick Fletcher, we have learned that **John Hrones** is doing fine at Digital. He and his wife Cynthia recently celebrated their daughter Emily's second birthday and had a little M.I.T. reunion picnic at their home in Needham.

Tom Murphy, who is looking forward to seeing everybody at our rapidly approaching reunion, is still employed by Sikorsky Aircraft as a Senior Materials Engineer, currently on the Navy LAMPS MKIII ASW Helicopter Program. Tom now has two boys, Chris, 4, and Andy, 8 months. . . . **Barry Mitnick** reports that his major news of the past year is his marriage last June to the former Margery Manesberg. They honeymooned in Quebec. Margy, who's originally from St. Louis, was Personnel Director of a company that made advertising calendars in Cincinnati. She's now Assistant Director, Student Programs and Counselling, for the Office of Residence Halls at Ohio State. . . . **Douglas Wilson** writes that he finished his Ph.D. in astrophysics at the University of Colorado in December, 1976, and has since been working on atmospheric muclear effects for E.G. and G. at Los Alamos. He has one daughter, Susanna, 2, and another child due in April.

John Moffatt was recently promoted to Scientific Applications Section Manager for the Kentron International Inc. ADP support services contract at the Department of Transportation in Cambridge. This followed a two-week management course at the home office in Honolulu which he attended with his wife, Vivian. John and Vivian still reside in Reading, Mass. . . . **Don Baker** has been working on a Bureau of Land Management contract for the last two years which involves taking measurements of continental shelf water in conjunction with biological baseline studies of oil lease areas from Long Island to Virginia. He calibrates, maintains and writes data reduction programs for their Neil Brown CTD/DO probes.

Rick Borken has left the University of Wisconsin to return to his home state of Minnesota and a new postition at Honeywell's Systems and Research Center. He is very pleased with the move and the job. . . . **Ronald Merrill** was a visiting Assistant Professor at the Rochester Institute of Technology from September, 1974, to August, 1977. He is currently Senior Research Chemist at Lifesystems Co. . . . And **Robert Dixon** is currently Senior Process Metallurgist for the Wrought CPM Products Crucible Specialty Metals Division of Colt Industries in Syracuse, N.Y.

And finally, an amusing note from **Ronald Bohm**, who reports that "Kathie, Matthew, Stuart and I have been adjusting to the Chicago area since our move from Miami in August. I am now working as Director of Management Decision Systems at Playboy Enterprises which is a Sloan School title for Executive Bunny Warmer!" — **Gail** and **Mike Marcus**, Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

69

Happy spring everyone. Hope you've all dug out from under the snow, or sand, you find yourself in (never use a preposition to end a sentence with).

Larry A. Viehland writes that he and **Kim (Claudia Winters) Viehland** have left New England for Larry's new job at Parks College of St. Louis University. Larry is teaching undergraduate research and performing research (apparently he did not find what he was seeking on the first search and now must re-search). Kim is house-hunting, jobhunting, and also preoccupied with Brian (born in early June, 1977) and Jeremy (3 years old).

Mike Laird is working in marketing at Cummins Engine and has recently vacationed in Egypt, Greece, and the High Sierras of Yosemite National Park. . . . **Irene G. Greif** has been appointed Assistant Professor of Computer Science and Engineering at M.I.T. for three years ending July, 1980. . . . **Carolyn S. Scott** writes that she has "three daughters, eight chickens, a cow, a dog, a cat, a small fruit orchard, a quarter-acre vegetable garden, and a husband who teaches chemistry at the best university in Nevada."

Lewis W. Flagg III, has been named Manager of Systems and Procedures for the Chicago

Regional Transit Authority. He resigned as Associate Dean for Fiscal Management, College of Social Services Administration, University of Chicago, to accept the post. . . . **Stephen Nord** reports that twin boys, Daniel and Jeffrey, joined the Nord family in 1977. Stephen is finishing his residency at the University of Chicago in mid-1978 and plans to head back to California with his family then. . . . **James P. Kornberg** writes that he and his wife Sally were blessed by the arrival of their daughter Mariah Anne on September 14, 1977. Jim is a senior staff consultant in occupational medicine at Arthur D. Little in Cambridge, Mass. He is engaged in some part-time clinical practice at the Veterans Administration Hospital in Bedford, Mass.

G. Joseph Horton is in the second year of a fellowship in neuroradiology at the University of Pittsburgh where he is an assistant professor in the medical school and postdoctoral fellow in organic chemistry with another M.I.T. alumnus, Jules Rebb. . . . **Edward Gruhl** received his J. D. degree in May and is working for Aldrich Chemical Co. in Milwaukee. With the addition of Jonathan in 1977, Ed and his wife now have four sons. . . . **Denny Albright** and his wife Sibyl are now settled in suburban Chicago where Denny is employed as Marketing Research Manager for A. B. Dick Co. The Albrights have an 18-month-old son, Greg Lawrence, and report recently seeing Ty Shen who has a young son named Christopher Ming. Ty is living in St. Louis.

David Silverman completed his Ph. D. at Stanford University in 1975 and began laboring at the Corporate Research Laboratory of Monsanto in St. Louis, Mo. In 1976, David married the former Joyce Goldberg of St. Louis. David also reports: "We are just completing the purchase of our home. My more carefree days are definitely over." . . . **Charles Bieger** has completed 1.5 years at Scripps Clinic and Research Foundation in La Jolla and will be continuing his post-doctoral education with a year at Scripps Institute of Oceanography where he will reportedly be "cloning genes from a marine luminous bacterium." . . . **Paul E. Beckerman** spent 1.5 years in Brazil researching that nation's economic policy. He is now teaching economics at the University of Illinois (Champaign-Urbana).

W. H. McCandless is busy at Teradyne, Inc., applying microprocessors in commercial test equipment. "For relaxation I fly small planes with my private pilot license." The class secretary, who generally confines his excursions into the atmosphere to long hops on large commercial aircraft and somewhat shorter hops over solid water (i.e., moguls) or liquid water anomalies, constructively suggests that classmate McCandless consider flying the small planes with their control devices rather than with his pilot's license if he should ever be in trouble while aloft.

Roger Chang exited from the Army in 1977, moved to a new home in Columbia, Md. (as of January, 1978), and is now working for Computer Sciences Corp. . . . **Kendall C. Marr** is a cardiology fellow at Cedars-Sinai Medical Center in Los Angeles, Calif. . . . **Sara J. Clope** is in an accelerated master's program at the Sloan School. . . . **Lee R. Brettman** completed his residency at Case Western Reserve in 1977 and is now doing a fellowship in immunology and infectious disease at N.Y.U. He is now board certified in internal medicine. Congratulations!!!! — **Peter Peckarsky**, Secretary, 950 25th St., N.W., Washington, D. C. 20037

Mr. and Mrs. H. Debose Montgomery were among some 40 members of the M.I.T. Club of Northern California at a special opening of the Stephen Wirtz Gallery in San Francisco. Early Last Winter; the Gallery was showing photographs by Harold E. Edgerton, Sc.D. '31, Institute Professor, Emeritus, and its proprietor hosted members of the Club at the wine-and-cheese-reception. Mr. Montgomery — who graduated from M.I.T. with the Class of 1971 with degrees in management and electrical engineering — is President of the Club. (Photo: Philip L. Molten, '55)

70

Welcome Spring. Received a letter from **Pete McCall**, who is continuing to work with a CPA firm in San Diego. Pete is inviting others to see him. . . . **John Holding** has accepted a new position as an in-house management consultant with Travenol Laboratories in Deerfield, Ill. He and Maureen both work near their new house in Evanston. . . . The M.I.T. industrial liason program's Associates Program has **Cynthia Bloomquist** as its Director. She and her husband have remodeled their 40-year-old house in Lexington and enjoy New England recreational opportunities. They went skiing with **Robert Gerber** who has successfully completed his first year of being an independent civil engineer and geological consultant. . . . Spurning the Olympic sailing grind, **Dave McComb** has recaptured the sporting fun of sailing and has won the North American Championship — Tempest Class.

John Huchra has engaged in extensive earthly travel as an astronomer. He has visited the new six-meter telescope in Russia and travels between Tucson, southern California and Chile observatories. . . . Claymont is the location of **John Brasunas**' blacksmithing and farming. He would like Michael Pagano to write. . . . **David Dobkin** is raising hamsters in New Haven, as well as collecting paperweights and knowledge. . . . **David Saar** heads the Advanced Electronics Group developing new products at Black and Decker Mfg. He is also a third-year law student at Maryland. **Charles Lieberman** is also there as an Assistant Professor in the Economics Department. He particularly likes his 14-month-old son and hopes classmates will visit or write. Gold mining next summer? See **D. Heflinger**.

Carl Yankowski flew into Fort Wayne — the test market of the Midwest — and informed us that he is the national marketing manager for Teem. He is working for the same firm, PepsiCo, for which Maggie, my wife, works. Carl is in Purchase, N.Y., and lives in Connecticut, while Maggie has a corporate attorney position with North American Van Lines. Sean continues to grow. — **Robert Vegeler**, Secretary, Kennerk, Dumas, Burke and Backs, 2120 Fort Wayne National Bank Bldg., Fort Wayne, Ind., 46802

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Hello from a snowbound New York. Hopefully we will be dug out by the time you all read this. Sorry about the January column; by the time the materials all reached me it was too late.

Dean Freedlander writes "A little M.I.T. rigor goes a long way in the delineation of unconscious fantasies. San Francisco provides plenty of them." Now what did he mean by that?! He is in his second year of a University of California residency in psychiatry program at Mt. Zion Hospital in San Francisco, having previously graduated from McGill University Faculty of Medicine. Dean served as the chief usher at **Larry Fisher**'s "Michigan wedding to an alluring 'Laurie.' " Larry, now disguised as Serpico, is living "under the disguise of a pathology resident in Denver."

After graduation with a Ph.D. in math in 1975, **Ken Holladay**, went to Caltech where he spent two pleasant years as an instructor. He has since moved to Miami, Fla., where he is earning a reputation for himself as a dynamic Assistant Professor in the Math Department. Presumably he is happy, healty and tan after all the years in the sun.

Michael Harvey gave a lecture on "An Introduction to the Microprocessor" in Lexington, Mass., last November. In 1976 he started his own company, Controlled Resources, of New Hampshire and has been involved in control electronics and computer interfaces, as well as being a consultant to the automotive industry, running seminars, and designing special scientific hardware.

Richard Weissberg passed through New York just before New Year's. He looked great, and I would have too if I had just returned from a week of skiing in Vail like he had. His company is sending him out to L.A. frequently now. He decided to take a skiing vacation on his way home. . . . **Charlie Mann** was up in New York earlier this fall for a holiday. He is still enjoying himself in D.C., and passed on the news that **Becky Donnellan** has gone to work for all of us taxpayers as one of the governmental agency lawyers.

I did manage to get snowed in this winter, and in December I got snowed in up in Boston. I spent the night with **Susan Leibenhaut**, one of the numerous women who became doctors in our class. She was planning a New Year's weekend camping trip in Vermont/New Hampshire and I was jealous. Susan is doing great.

Carliss Baldwin was in town for a conference at the end of December. She had just finished her first semester at Sloan School and is enjoying her work. . . . Deborah and **John Gunther** have left their house on Wentworth St. in Anchorage. . . .

Ric DiCapua continues to be involved with his company Minipak, S.A. in Bogota, Columbia. He passed through New York on business last fall.

That's it for class news for this month. **Dick Fletcher** will be writing in this spot next month, and two months from now I'll be back with whatever notes of interest, or otherwise you send in or I hear through the grapevine. — **Wendy Elaine Erb**, Co-Secretary, 177 East 75th St., Apt. 21B, New York, N. Y. 10021

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Thanks to those who have written in gratitude for the column (both of you).

Steve Warsof heads this month's list; he is an intern in obstetrics and gynecology at George Washington University Medical Center. While there, he has met fellow A.E.Pi's **Bill Stern** and Jerry Rosen ('71). . . . **Dave Sebolt** is having a wild, sensuous time in Indiana (?), teaching and grinding through a master's program. Never did take much to please an S.A.E. . . . **Dean Kross** is "throughly enjoying the responsibility and satisfaction that is part of my medical internship experience at the Johns Hopkins Medical Center." Would that we all could be as happy.

A few more incipient and new M.D.'s wrote this month, and they predominate: **Jeffrey Seltzer** is back in Boston interning at B.U. after Buffalo snow "too heavy to be believed." Jeff finally married long-time friend Hillary Steiner and hopes to stay in the area. . . . **Mike Cedars** finished medical school at the University of California at San Francisco and moved to Los Angeles with hound Brandy ('71) to pursue a general surgery residency at U.C.L.A. . . . **Carl Rosenberg** "made it to intern: they haven't caught up to me yet." . . . **Tony Pellegrino** is currently a first-year medical student at the University of Massachusetts in Worcester.

Tim Backstrom writes that he will graduate from Yale Law School this year to work in the E.P.A. General Counsel office in Washington, D.C. Tim adds that its environmental orientation fits well his years of interest and training therein. . . . **Doug Mink** writes that at graduation he married Missy Hannah ('74) and, after receiving an M.S. in planetary science, found himself unemployable enough around Boston to seek grad school at Cornell with Missy. She got in, he didn't, but he was offered a lab job in their department of stars, where he is involved in the discovery of Uranus' rings (well, maybe *yours* have them!)

Doug Levene is applying to law school to forestall the real world. He would like to hear from others involved in international law. . . . **Tony Scandora** actually wrote to tell of his exploits as Henrik in "A Little Night Music" in Illinois. So who hasn't done it?

I'm snowbound and still at the Charles Playhouse in "Fantasticks." Come see it and say hi! — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

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Thanks are in order to those of you who have contributed to the M.I.T. Challenge Fund, for you have provided me with the bulk of my material for this month's column.

Bob Rosenschein worked at Data General Corp. in 1976 as a programmer. Then he spent a year in Jerusalem, Israel, teaching computer programming at a technical college, as well as programming at the Bank of Israel. He has returned to study computer science at the University of Maryland. . . . And here's some news from three more computer scientists: **Gerard Rudisin** is working on a master's degree in computer science at U.C.L.A. in the area of secure, distributed computer systems. . . . **Michael Wilens** is completing his Ph.D. in Computer and Communication Sciences as well as a master's in business administration, both at the University of Michigan. . . . **Woody Pidcock** writes, "I am working as a computer programmer for BP Technical Services, Inc. in Braintree, Mass. I danced at the Whole World Celebration with Veronica's Vagabonds. . . . Still single. . . . Involved with the Boston Lutheran Urban Ministry. Plan to go back to school for master's in operational research in U.K."

Dale A. Coleman had this to say, "I am currently living in West Chester, Penn., and working for Burroughs Corp. in Downingtown, Penn. My job currently involves the evaluation, specification and testing of medium- and large-scale integrated circuits." . . . **Jeffrey W. Moore** has been working at Mass. General Hospital doing bioengineering research in the field of physiological noise studies, applying digital signal processing. (My stomach is growling at the very thought of it.) . . . **Abbot Low Moffat II** continues to work on solar energy research and is expecting a baby late in February, 1978. (Please excuse the verb tense; it is now January.) Abbot received the Cabot Fellowship for research in alternative energy sources, and expects to receive the M.S.C.E. in June, 1978. . . . Here's another soul still at M.I.T. **Walter P. Lapatovich** is pursuing a Ph.D. in physics with research involving laser spectroscopy of weakly bound alkali-rare gas molecules.

Thomas Lizzi took pity on me and my usual sparsity of class notes and wrote me a nice letter in which he said the following, "On the first Flag Day after graduation Christine Cable (Geneva College) and I were married. I took a job with Jones & Laughlin Steel Corp. in Cleveland, Ohio, as a metallurgist in the steelworks. Two years in the Smokey City were enough for me so this summer we moved to the small town of Towanda, Penn., in the heart of the Endless Mountains. I'm now working for GTE Sylvania — Precision Materials Chemical/Metallurgy Division as a metallurgist and liking it all very much."

Class Vice President, **Ilene Gordon** moved to London, England, at the end of January and will continue to work for the Boston Consulting Group abroad.

Last, but not least, early in January I had the pleasure of dining out with **Steve Streifer**, **Stephen Chapman**, **Lenny Deroma**, **Evan Schwartz**, **Cliff Wald**, and **Peter Blanshan**. Steve Streifer is working in Washington, D.C., for the Military Sealift Command as a Naval Architect. He is more than happy to give you a business calling card which indicates this. Steve Chapman works here in Boston for Stone & Webster. Lenny is faring well in the Big Apple working for Citibank. Evan is in medical school in Buffalo, N.Y. Cliff is still working for the Louis Dreyfus Co. but he's been relocated to Stamford, Conn. And Peter is loving every minute of Harvard Business School.

That wraps it up for now. — **Jennifer Gordon**, Secretary, 22 Centre St., #9, Cambridge, Mass. 02139

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The mails have finally begun to yield their bounty. Hurrah!

From **Gwen Champion** we learn that since her graduation in February, 1976, she worked as a chemist at Polaroid, started graduate school at Vanderbilt University, and is now to be found at Johns Hopkins pursuing a Ph.D. in chemistry. **David Maass** tersely writes that he is a "Structures Engineer at Sikorsky Aircraft." **Neil Kaden** reports that he is " 'Smalltalking' away at the Computer Systems Research Group, University of Toronto."

Bob Hossan says he is now working for M.I.T. as the Assistant Director of the Chemical Engineering Practice School at the General Electric Co. in Waterford and Selkirk, N.Y. **Rob Shults** states that he "returned to the East Coast this summer after a warm, sunny year at Stanford. . . now working with Sweet Associates, a construction company based in Schenectady, N.Y. Getting my hands dirty, and enjoying it." **Neil Gerr** succinctly reports that he is "still studying, partying, and hunting." As for what/whom he is hunting, he doesn't state.

Marty Deneroff reports that since graduating "I have been working for Motorola. I recently was transferred from Illinois back to New Jersey. I am planning to go to graduate school in the fall, possibly at the Institute." **Dominick Bruno** writes that he is "currently employed by Grumman Aerospace Corp., studying for a master's degree in Aeronautical Engineering at Polytechnic Institute of New York under a company-sponsored fellowship program." Not bad at all!

I have a long letter from **Gary Kaitz**, who took the M.C.P. degree from the 'Tute and now works for a consulting firm in Washington, D. C. He has some interesting observations on D. C. vs. Beantown: "I already no longer think Boston is the Hub of the Universe, only a nice place to live. In some ways Washington is similar to Boston. It offers all the same culture and hangouts, but at higher prices, probably do to Washington's high young professional population vs. Boston's student population. The land is much prettier here — more open land, more parks. The mountain ranges of western Maryland are supposed to be much prettier than the Berkshires. My only complaint about Washington is the lack of an ocean. It is a four-hour drive to the Atlantic. Washington is an inland city, with almost no industry (all jobs are services — retail trade and professional, mostly)." It sounds like quite a change from the city your Secretary still regards as the Hub. But then again, I do admit to having a *slight* bias towards Boston.

(Harry) Lee Gearhart has written me an amazing letter. Simply amazing! " . . . This was going to be a rather colorful letter, but my sister stole my set of Flair pens. Herein you will find news, trivia, anecdotes, impressions, lies, damn lies, and statistics. Caveat emptor . . . concerning my what/where/why-abouts. In August, 1976, I left for Pittsburgh, Penn., where I became (and still am) a graduate student in the Metallurgy Department at Carnegie-Mellon. I'm working towards a two-year degree they refer to as 'Master of Engineering,' and I should terminate in May. I guess after that I'll be empowered to wear the pointy hat with stars on it and give out incantations like 'linear elastic fracture mechanics!' Can't wait. . . . Carnegie-Mellon, though mainly an engineering school, is quite a bit different from M.I.T. . . . the atmosphere of this place is much more practice-oriented. People here seem to be obsessively concerned with what they're going to do when they get out and worry about their careers from their freshman year onwards. I've even run into some undergrads who admit they didn't come to get an education but rather to get a good job when they graduate. I'm probably overly romantic, but this pains me. Hell, they can always learn a trade in graduate school. . . . Pittsburgh is not as bad a town as its national image would lead one to believe. In general, you can't see all the sights in an afternoon — and then go to lunch, as some wags have suggested. . . . Other people here include: **Bob Fitzgerald**, **Tom Martin**, **Bill Queen**, **Mary Heinking**, and someone known only as Howie (the last four in the business school). . . . The only real hacking I've done since I've been here was the last weekend in September, 1977, when I and some cohorts (Fitzgerald included) built a park composed of 30 square meters of sod, a pair of benches, and a small tree on the roof of Science Hall, an eight-story building; 'twas quite a pleasant place. Physical Plant, however, saw it as a threat on a par with communism and so dismantled it." It sounds, Lee, that Carnegie-Mellon is proving to be a rather pleasant experience!

And **Steve Lubar** has written me a short, cryptic letter: "I am attending the University of Chicago, studying for a Ph.D. in history of science. I live in the city with hundreds of orchids and a feebleminded dog." I do hope someone will look in on him — it must be a curious sight.

As for your Secretary, he has just recently lost his first job and is now unemployed. Sometime in the future I shall explain further. However, I have found a new measurement for success. Rather than the traditional ruler, the dollar, these days I measure it by the number and quality of subpoenas I get!

Remember, don't forget to vote in the upcoming Corporation election and keep writing to me. — **Arthur J. Carp**, Secretary, 67 Badger Cir., Milton, Mass. 02186

ALUMNI TRAVEL PROGRAM 1978-79

This special travel program, to some of the most interesting areas in the world, has been especially designed for alumni of Harvard, Yale, Princeton, M.I.T., Cornell, Dartmouth, Univ. of Pennsylvania and certain other distinguished universities and for members of their families. It is consciously planned for persons who normally prefer to travel independently, and covers lands and regions where such persons will find it advantageous to travel with a group.

The itineraries are designed for the intelligent traveler, and offer an in- depth view of historic places, ancient civilizations, archeological sites and artistic treasures, as well as interesting and far-flung cultures of the present day and spectacular scenery from virtually the four corners of the globe. The programs are, however, also planned to incorporate generous amounts of leisure time and to avoid unnecessary regimentation so as to preserve as much as possible the freedom of individual travel, while utilizing the savings and the practical convenience which group travel can offer.

Considerable savings have been obtained by using special reduced fares offered by the world's leading scheduled airlines, fares which are generally available only to groups or in conjunction with a qualified tour and which offer savings of as much as $500 and more over normal air fares. In addition, special group rates have been obtained from hotels and sightseeing companies. By combining these savings with a careful selection of the finest available hotels and facilities, it is possible to offer travel arrangements of the highest standard at moderate and economical cost.

AEGEAN ADVENTURE — 23 Days: The archeological treasures of classical antiquity in Greece and Asia Minor and the islands of the Aegean, with visits to Constantinople (Istanbul), Troy, Pergamum, Smyrna (Izmir), Sardis, Ephesus, Epidauros, Mycenae, Olympia, Delphi and Athens, as well as a cruise through the Aegean to the islands of Crete, Santorini, Mykonos, Rhodes and Patmos. Departures April through October.

MEDITERRANEAN ODYSSEY — 22 Days: An adventure into realms of antiquity in the western Mediterranean, with the ruins of Carthage and the Roman cities of Africa in what is now Tunisia, the splendid Greek temples of Sicily (including the famed "Valley of the Temples" at Agrigento and the ruins of Syracuse, the city of Archimedes), the remarkable Norman churches of Palermo, dating from the age of William the Conqueror, and the fortress cities of the Crusader Knights of St. John on the island of Malta. Departures March through October.

VALLEY OF THE NILE — 17 Days: A detailed view of one of the greatest civilizations the world has ever known, the civilization of ancient Egypt along the valley of the Nile. The itinerary includes Cairo, the pyramids of Giza, Sakkara, Dashur and Meidum, Memphis, Abydos, Dendera, the great temples and monuments of Luxor, including the Valley of the Kings and the tomb of Tutankhamun, and a cruise on the Nile of Upper Egypt to visit Esna, Edfu, Kom Ombo and Aswan, as well as the great monumental temples of Abu Simbel near the border of the Sudan. Departures January through December.

THE ORIENT — 29 Days: A magnificent survey of the Orient, including the exotic temples and palaces of Bangkok and the ruins of ancient Ayudhya, the great metropolis of Singapore, the enchanted island of Bali with its unique artistic heritage, the famed port of Hong Kong on the border of Red China, and a comprehensive visit to Japan which places special emphasis on the cultural treasures and the tranquil beauty of classical Japan at the historic city of Kyoto and at Nara, Uji, Kamakura and Nikko, as well as the mountain scenery of the Fuji-Hakone National Park and the modern capital at Tokyo. Optional visits are available to the ancient temples of central Java and the art treasures of the National Palace Museum in Taiwan. Departures March through November.

BEYOND THE JAVA SEA — 32 Days: A remarkable journey through the tropics of the Far East, from the port of Manila in the Philippines to the tea plantations and ancient civilizations of Ceylon, the Malay Peninsula, the Batak tribes of Sumatra, the ancient temple ruins of Java, the fabled island of Bali, headhunter villages in the jungle of Borneo, and the unforgettable beauty of the lights of Hong Kong. Departures January through November.

MOGHUL ADVENTURE — 30 Days: The great historic and cultural heritage of India, combined with the splendor of ancient Persia and a journey into the high Himalayas in the remote mountain kingdom of Nepal: imposing Moghul forts, ancient temples, lavish palaces, the teeming banks of the Ganges, snow-capped mountains, picturesque cities and villages, and the Taj Mahal, culminating with the famous mosques of Isfahan and the 5th century B.C. palace of Darius and Xerxes at Persepolis. Departures January through November.

SOUTH AMERICA — 28 Days: An unusually comprehensive journey through the vast continent of South America, from the Inca ruins and colonial heritage of the western coast, amid the towering snow-capped Andes, to the great Iguassu Falls and the South Atlantic beaches of Brazil. The itinerary includes the colonial cities of Bogota, Quito and Lima, the great Inca centers of Cuzco and Machu Picchu, La Paz and Lake Titicaca, the magnificent Argentine Lake District at Bariloche, Buenos Aires, the Iguassu Falls, Sao Paulo, Brasilia and Rio de Janeiro. Departures January through November.

THE SOUTH PACIFIC — 28 Days: An exceptional tour of Australia and New Zealand, with Maori villages, boiling geysers, fiords and snow-capped mountains, ski plane flights, jet boat rides, sheep ranches, penguins, the real Australian "Outback," historic convict settlements, and the Great Barrier Reef. Visiting Auckland, the "Glowworm Grotto" at Waitomo, Rotorua, the Southern Alps at Mt. Cook, Queenstown, Te Anau, Milford Sound and Christchurch in New Zealand, and Canberra, Tasmania, Melbourne, Alice Springs, Cairns and Sydney in Australia. Optional extensions available to Fiji and Tahiti. Departures January through November.

EAST AFRICA — 21 Days: A distinctive game-viewing and photographic safari to the wilds of Africa, covering some of the greatest wildlife areas in the world. From the semi-desert of Kenya's Northern Frontier region and the vast game-filled plains of the south to the lakes of the Great Rift Valley and the snow- capped peak of Kilimanjaro, the itinerary includes Nairobi, the Nairobi National Park, Treetops, Meru National Park, Samburu Game Reserve, the Mt. Kenya Safari Club, Lake Nakuru National Park, Lake Naivasha, an extended stay in the great Masai-Mara Reserve, Amboseli National Park and Tsavo National Park, with optional visits to the coast at Mombasa and Lamu. Departures January through December.

Prices range from $2,295 to $3,575 from U.S. points of departure. Fully descriptive brochures are available on each tour, setting forth the itinerary in detail with departure dates, relevant costs, hotels used, and other information. For full details contact:

ALUMNI FLIGHTS ABROAD
White Plains Plaza, One North Broadway, White Plains, N.Y. 10601

Liturgical Vessels Commissioned for M.I.T.

New liturgical vessels — being shown here by the Reverend Robert Moran, Catholic Chaplain — are now in use at Catholic services in the M.I.T. Chapel. The vessels are the work of ceramicist Ragner Naess of Brooklyn, N.Y., whose father is Ragnar D. Naess, '23, of New York City; they were designed, the artist says, to be practical as well as harmonious with the distinctive lighting and color of the Chapel in which they're used. The vessels were commissioned by Professor Benjamin L. Averbach, Ph.D. '47, of the Department of Materials Science and Engineering. (Photo: John M. Grunsfeld, '80)

Keeping Up to Date in Engineering

A series of conferences on recent technological advances and current issues is now part of the program of the Center for Advanced Engineering Study — a new dimension added to the Center's activities in continuing professional education for engineers.

Under the program, C.A.E.S. will help faculty develop and stage meetings on current issues — and its resources will also be turned to the task of publicity. C.A.E.S. has already taken this role for conferences on computer-aided manufacturing, held last fall, and textile substitution, held early this year. Next on the schedule is a meeting on the management of large disasters; and events in the Rocky Mountain area and in the Netherlands are being planned.

Exploring the South African Connection

How should M.I.T. investment policies be affected by the racial policies of South Africa?

That question looms large on the spring agenda of the M.I.T. Corporation's Committee on Shareholder Responsibility, and discussion is beginning.

Already the Committee has circulated a questionnaire on South African involvement and policies to corporations in which the Institute owns stock; the results will be an important input into the Committee's deliberations, says Walter L. Milne, Special Assistant to the Chairman of the Corporation who serves as Secretary of the Committee.

The Committee will also be guided by information from the Treasurer's Office on the role of various corporate investments in M.I.T.'s total financial management, Mr. Milne says.

On the basis of questionnaire responses, most companies fall into one of three groups: some claim little or no South African involvement; some make sales in South Africa through agents and claim no direct role in the nation's policymaking; and those with South African employees claim that affirmative action is in effect there.

Video Instruction: "Now I Can Talk 8.02!"

Is sitting around a television set for a couple of hours every day any way to learn college physics?

It is for several minority-group students at M.I.T., who have achieved marked success in a program that couples tutored video instruction — TVI — with one of the hardest first-year physics courses in the world. Students attend the regular physics lecture, then later in the same day view a videotape of the lecture with a tutor.

The course is 8.02 — electrostatics, field concepts, electric currents and magnetic fields, induction laws, field energies, Maxwell's equations, and circuit theory. It's a formidable course — especially so for students who fear that their high school preparation is inadequate — a situation which often occurs for minority-group students.

Though the failure rate for 8.02 is high, none of the minority-group students who took advantage of the special TVI program had to repeat the work. Indeed, the program was so successful in the fall term that three TVI sessions of 8.02 are now being given in the spring term.

The plan has students attending the regular lectures in 8.02; later the same day they go to a TVI session at which they see an unedited videotape of the earlier physics lecture. The important difference the second time around is the presence of a tutor, who can stop the videotape whenever a student has a question or needs help getting a particular point.

Sylvester J. Gates, who served as the senior tutor for the pilot program last fall, says the TVI format allowed student-to-student interaction at a level "which simply cannot be matched in a formal lecture. The students can interact with each other when a question first comes to their minds," says Dr. Gates, "and there are many cases of students teaching students."

How do the students feel about TVI? Professor Wesley L. Harris, Director of the Office of Minority Education, says the students are enthusiastic. "TVI has increased my level of understanding," one student told him. "I now feel very secure in my discussions of 8.02. I even tutor occasionally."

Another student said his "level of per-

formance" was up. "Almost all questions have been answered and clarified," he said, "and I'm now more confident of myself when doing problem sets and quizzes." But the ultimate praise came from a third student, who said the fuller explanations available through TVI were especially helpful. "For sure, I can now talk 8.02," he said.

M.I.T. at Home— Evenings and Weekends

The same combination of tutor and classroom video which has been so effective for M.I.T. undergraduates who need a little extra confidence in approaching tough subjects (*see above*) is now available for practicing engineers who want to update their professional skills on an individual basis.

The Center for Advanced Engineering Study has long offered tutored video instruction (TVI) to companies who wanted to enroll their employees and designate a company-paid tutor to show the video tapes and answer questions. Now groups of three to ten engineers can arrange to do the same thing — in the evening, on their own time — the tutor being an instructor or graduate student from M.I.T. They'll be enrolled as M.I.T. Special Students and pay regular Special Student tuition, receiving academic credit for TVI courses successfully completed.

M.I.T. Joins the U.S.S.R. in Management

For more than ten years M.I.T. Sloan Fellows have been traveling to the U.S.S.R. each spring — part of a European tour in which these young executives learn about business institutions and practices on the other side of the Atlantic. As a result of these contacts in the Soviet Union, eight Russian executives have been enrolled as Sloan Fellows in the last four years — including three this year. Indeed, the Sloan School is "the only U.S. management school where Soviets are enrolled in a degree-granting program," says Peter P. Gil, Associate Dean.

Now the relationships have been formalized and extended in a Soviet-M.I.T. agreement which provides for "a broad base of cooperation between scientists and specialists in the management field." Dean William F. Pounds of the Sloan School of Management, who will administer the agreement for M.I.T., guesses that it will include exchanges of scientists and specialists, exchanges of information and documentation, joint research projects, exchanges of research results, and the organization of joint courses and conferences.

Gulf Gives $1 Million for Energy

A $1 million grant for energy research and education has come to M.I.T. from the Gulf Oil Foundation — $500,000 to be used as an endowment for the Energy Laboratory's Center for Energy Policy Research, $250,000 for research on the utilization of coal and other fuels, and $250,000 for general Energy Laboratory support.

It's the largest grant of its kind that Gulf has ever made outside of the Pittsburgh area, Gulf's headquarters. The $1 million will be payable over five years, and President Jerome B. Wiesner says it "focuses on problems of the highest priority in expanding the nation's energy resources."

Computers at M.I.T.: A Longer View

Are changes in technology about to render obsolete some of the Institute's important resources in computation and data processing? And how should M.I.T.'s computer systems and services be structured in the 1980s and 1990s?

Chancellor Paul E. Gray, '54, and Provost Walter A. Rosenblith have handed these tough questions to a blue-ribbon Committee on Future Computational Needs and Resources, chaired by Professor Michael L. Dertouzos, Ph.D.'64, Director of the Laboratory for Computer Science; his Co-Chairman is Weston J. Burner, Director of Information Processing Services.

As he began work with his colleagues on the Committee, Professor Dertouzos noted that computer equipment costs are trending down and there is "increasing proliferation of local systems" — including text editors — in the Institute. So he thinks communication networks, rather than new equipment, may be important.

And the Committee will focus special at-

In Memory of Martin Luther King

A silent walk in the snow in tribute to Martin Luther King, Jr. "Keeping the Dream Alive" was the theme of M.I.T.'s observance of the anniversary of the civil rights leader's birthday on January 13; participants walked together from the Rogers Building to Kresge Auditorium, where Jerome H. Holland, former Ambassador to Sweden who is a member of the M.I.T. Corporation, was principal speaker. In the picture, right to left, are President Jerome B. Wiesner; Dr. Holland; Clarence G. Williams, Special Assistant for Minority Affairs; Walter A. Rosenblith, Provost; Paul E. Gray, '54, Chancellor; and Joseph Bartie, Co-Chairwoman of the M.I.T. Minority Interest Group which sponsored the observance. (Photo: Calvin Campbell)

tention on uses of computers in education. Instead of our "current unstructured educational use of computers," Professor Dertouzos suggested, "it would be nice if students could learn one or two programing languages when they enter the Institute and could then count on using those languages for many of their courses throughout their stay at M.I.T., from a variety of easily accessible terminals in academic buildings and in student residences."

The M.I.T. Symphony to play at Avery Fisher Hall

The 100 members of the M.I.T. Symphony Orchestra, under the direction of Professor David M. Epstein, will play in Avery Fisher Hall in the Lincoln Center, New York, on Wednesday evening, April 12.

The program will include Stravinsky's "Scherzo a la Russe," Kurt Weill's suite from "Der Silbersee," and Berlioz' "Harold in Italy." Professor Marcus Thompson will be soloist in the Berlioz.

The concert will begin at 8:30; dinner will be served at the Top of the Met beginning at 6 p.m., and the concert will be followed by a reception for the musicians in the foyer of Avery Fisher Hall. Tickets for the concert ($5) are available from the M.I.T. Alumni Center of New York, 50 East 41st St., New York, N.Y., 10017, telephone (212) 532-8181; the Center and Council for the Arts at M.I.T. are cosponsors of the evening events.

The M.I.T. Symphony has received acclaim not only for its accomplished performance but also for playing important neglected works such as the Kurt Weill piece, which the Symphony will be giving its New York premier performance.

For Dormitory Improvements

Alumni who want their gifts to the Alumni Fund to make possible renovations and improvements in the Institute Houses are invited to mark them for the Campus Residence Fund — a new unit designed to parallel the long-established Independent Residence Development Fund (I.R.D.F.) for fraternities. The goal is a $100,000 capital fund from which can be made low-interest loans for projects in the residence system. The first gift to C.R.F. came this winter from Baker House — a check for $250 presented to James A. Champy, '63 (left), Executive Vice President of the Alumni Association, by Gary Gammon, '78, President of Baker House, and Ursula Wolz, '78, a Baker House resident who helped win the money in the first place. Baker House's gift to C. R. F. was half of its first-prize winnings in a recycling contest sponsored by Miller Brewing Co.; Baker House beat Burton and McCormick by collecting nearly 6,000 bottles and cans. The other half its $500 first prize was given by Baker House to the Boston Globe's Christmas charity fund. (Photo: Calvin Campbell).

A Challenge to WTBS' License

The application from WTBS, the student-operated FM station, to increase its power from 10 to 200 watts remains before the Federal Communications Commission, while students at Lincoln-Sudbury Regional High School have petitioned F.C.C. to operate their proposed WLSR-FM on the same 88.1 megaHertz frequency. The two stations agree that both can't win: the two signals would interfere with each other in much of their prime listening areas.

Robert Bjorge, '78, Chief Engineer at WTBS, thinks there's only a "very remote" chance that M.I.T.'s station will lose its license, which comes up for renewal in April. WTBS is the only noncommercial broadcasting station in Cambridge, he says, and it has a "good record" of public service — a big commitment to "locally-produced public affairs programs" and "specialty programs" not aired elsewhere in Boston.

Above: The indoor tennis season ended abruptly on January 20, when high winds in a heavy snowstorm ripped the fabric cover of the air-supported J. B. Carr Indoor Tennis Facility. Ross H. Smith, Director of Athletics, said that the cover was due for replacement after more than six years of service; the nominal life span is from five to eight years. But he said repairs will cost $60,000 to $75,000 and take up to six months. (Photo: Steven Solnick, '81, from The Tech)

The contribution of Samuel Nixon, Jr., '77, to WTBS' community service is a gospel music show he calls Good News. There are other special music and commentary shows, community service programs, and broadcasts of major events at M.I.T. — an average of over 22 hours of programming a day, seven days a week. (Photo: Charles Irwin, '80, from The Tech)

Right: As the deadline approached early this year, Peter H. Richardson, '48, Director of Admissions, was forecasting a total of about 4,500 applications from prospective members of the Class of 1982, and he had enlisted some 60 members of the faculty to help read and evaluate the flood of hopefuls' documents. At a briefing session (above), Mr. Richardson said he hoped each applicant's file could be read by at least two faculty members; the first reading would take at least 20 to 30 minutes, he said, the second somewhat less. By mid-March, with the reading completed, the same faculty members were participating in what Mr. Richardson calls "the round-up" — the final selection process. (Photo: Calvin Campbell)

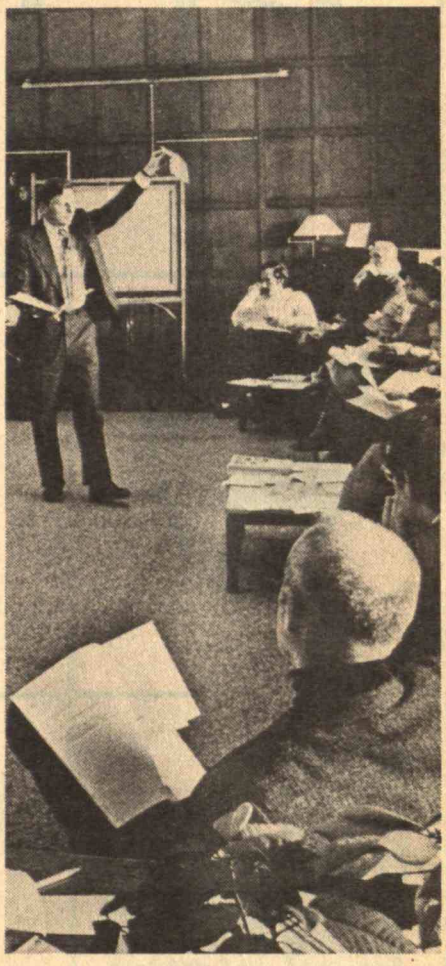
Solow on Inflation

"What We Know and Don't Know About Inflation" is the topic for two lectures by Robert M. Solow, Professor of Economics, in Kresge Auditorium on April 20 and 27. They're the annual Killian Award lectures for 1978, the result of Professor Solow's selection for this special honor among members of the M.I.T. faculty. Both lectures, open to the public, will begin at 8:30.

A Record for Early Admissions

Applications for M.I.T.'s Class of 1982, entering next September, are up, and already a record number of early applicants — a total of 331 — are assured of places in the Class.

There were 646 early-action applications from students who wanted their qualifications reviewed as of December 15. M.I.T. agreed to admit more than half of them — 255 men and 65 women. That's a record-high percentage of women as well as a record total of early-action cases; nine of the admitted students are blacks and two are Mexican-Americans.



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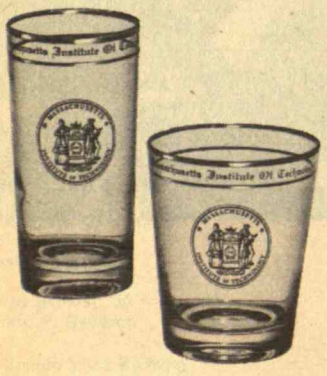

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Director's Chair, Glassware	(per order)	2.50	3.50	4.50
Personalized Plaque	(per order)	1.25	1.75	2.25
M.I.T. Chair Cushion & Tie	(per order)	1.00	1.25	1.50

M.I.T. Chairs: Freight charges collected upon delivery.
Please allow approximately 4 weeks for delivery.

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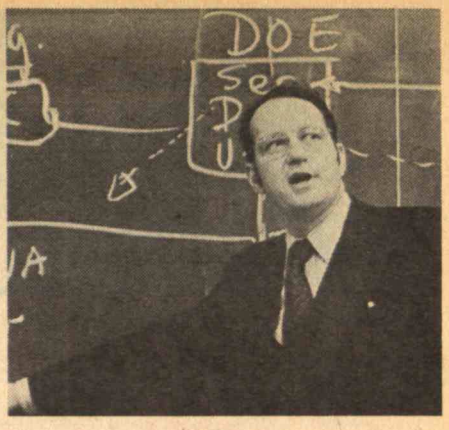


One of the strengths of the Department of Energy, says Professor John M. Deutch, '61, former Head of the M.I.T. Department of Chemistry who is now D.O.E.'s Director of Energy Research, is that it embraces energy issues from basic research through regulation and marketing. So does Dr. Deutch in his new job; at an M.I.T. seminar in January, he talked easily of the "complicated political and social problems" which stand in the way of nuclear power and of D.O.E.'s research and development on coal gasification and liquefaction ("I never thought I'd be so interested in a chemical reaction involving carbon," he told his M.I.T. audience.) (Photo: Calvin Campbell)

Deutch: Modulating Energy with Science, Technology, and Political Reality

John M. Deutch, '61, Professor of Chemistry who left the Headship of the Department last fall to become Director of Energy Research in the U.S. Department of Energy (he was confirmed in that job by the Senate on December 6), is by no means a typical chemist ensconced in his paneled study with a test-tube-filled laboratory next door. His interest in public policy dates back to his undergraduate years, when he combined work in history and economics at Amherst with his study of chemistry at M.I.T., and to assignments for the Defense Department Systems Analysis Group while an M.I.T. graduate student.

"He's wired in like crazy," said Eugene Fubini, Chairman of the Defense Science Board, during the winter when William D. Metz of *Science* Magazine asked about Dr. Deutch's ability to work with the federal bureaucracy.

Back at M.I.T. in January to give a seminar during the Independent Activities Period, Dr. Deutch made it clear that he likes his new assignment — and expects to do some good in it.

It's a big job — management of a $400 million basic research program, direct supervision of five D.O.E. laboratories and a good deal of clout in determining programs at the other four, and in general the role of D.O.E.'s impartial resident expert on science and technology. In these assignments he has a unique asset, he told his I.A.P. audience: his Office of Energy Research wasn't in the original organization chart for D.O.E.; it was added by Congress, which is now "extremely supportive" because "it regards the Office as being its own."

No Scary Talk of Future Energy Gaps

After a few months in Washington, Dr. Deutch concludes that D.O.E. has one very special organizational advantage in tackling the development of energy technologies: it has responsibility, within a single department, from research through development, commercialization, marketing, and even regulation.

"It's absolutely impossible to do any kind of sensible research and development planning or execution without having clearly in mind what the future market and regulatory environments are going to be," Dr. Deutch said. For perhaps the first time in a major federal agency, hard technology and regulatory concerns can be mixed at the source.

For examples, consider his comments on the future of solar and nuclear as U.S. energy sources:

☐ There is "not a shred of evidence that another nuclear power plant will be built" in this country, Dr. Deutch told his I.A.P. audience — not because the technology is inadequate or immature but because there is "an unbelievable absence of public confidence." Every new power plant and every waste disposal facility "has to be in somebody's congressional district."

☐ If large-scale solar energy utilization occurs in the U.S. in the next decade, it will be due in large measure to the enthusiasm of Congress, whose members seem to want "solar now, regardless of the cost."

But despite the technological irrationality and wishful thinking which some people associate with such points of view, Dr. Deutch is not a prophet of doom. "I'm not a person who enjoys talking about future gaps in a scary way," he said at M.I.T. "Regardless of imperfections and interventions, the economic system has a way of making things intersect at the last moment. In some sense we'll make it."

Moore . . . Hotte . . . Proctor . . . Wick . . . Eleven Alumni Leaders Named for New Offices in 1978

Joe F. Moore, '52, President of Bonner and Moore Associates, Inc., Houston, will lead the Alumni Association in 1978-79.

And three leading alumni have been nominated for membership on the M.I.T. Corporation for five years beginning in July, 1978:

☐ **Paul Hotte,** '42, Vice President (Investor Relations) of P. R. Mallory and Co., Inc., Indianapolis.

☐ **Stanley M. Proctor,** '43, Founder and President of the Stanley M. Proctor Co., Cleveland.

☐ **Emily L. Wick,** Ph.D. '51, Dean of the

Deutch: "Just the Man" for Energy

John M. Deutch, '61, who left the M.I.T. Chemistry Department this winter to become Director of Energy Research in the Department of Energy, "may be just the man to rub some rough edges off the fledgling agency's research program," says Robert Cooke, Science Editor of the *Boston Globe*.

After a brief interview, Mr. Cooke wrote that Dr. Deutch "sees energy as 'the outstanding technical problem for the next few decades.' "

"My first task," he told Mr. Cooke, "will be to try to assist in developing a research and development strategy for all forms of energy supply." Then, he said, he wants "to become concerned with nuclear waste management policy. And I'm certainly going to be pushing solar energy, along with energy efficiency in industry. I'm also very interested in coal conversion," Dr. Deutch told Mr. Cooke.

Though he was raised in the Washington, D.C., area, Dr. Deutch told Mr. Cooke that he intends to return to Boston — and "I hope to return to M.I.T." His desk as Head of the Department of Chemistry awaits him; in two years since Dr. Deutch took on that job, President Jerome B. Wiesner told Mr. Cooke, "he revitalized and gave tremendous spirit to the Department."


J. F. Moore


P. Hotte


S. M. Proctor


E. L. Wick


H. P. Aldrich, Jr.


C. K. Holmes, Jr.

Notice

In accordance with Sections 2 and 4 of the Bylaws of the Corporation of the Massachusetts Institute of Technology, on April 6, 1978, ballots for the election of a nominee for membership in the Corporation were sent to alumni(ae) as follows:

1. Undergraduate class receiving a Bachelor's degree during the current calendar year (1978).
2. Graduate students completing their terminal year of study and receiving an advanced degree during the current calendar year (1978).
3. Those who graduated from the Institute or received a graduate degree during 1977.
4. Those who graduated from the Institute or received a graduate degree during 1976.

If you should have received a ballot but did not, please contact Rosemary Carpenter at (617) 253-8221.

Candidates for nomination are:

Jesse M. Abraham '77
Michael A. Brintnall '77 G
Carolyne Clay '78 G
Victor J. Franckiewicz Jr. '76 G
Gary G. Gammon '78
Alan M. Goldberg '78 G
Brian G. R. Hughes '77
Robert Jacobsen '78
Vijay K. Singhal '76 G
Robert A. Wasson '78 G

The ballot must be returned to the Alumni Association, Room 10-115, Massachusetts Institute of Technology Cambridge, Mass. 02139 by **May 12, 1978.**

Faculty and Professor of Chemistry at Mount Holyoke College, South Hadley, Mass.

These choices — and others to fill vacancies on the Board of Directors of the Alumni Association — were made by the Association's National Selection Committee late last year. The Selection Committee itself was designated in a national ballot of members of the Association in the spring of 1977; a similar balloting for the 1978 Selection Committee will be conducted in April.

Other choices by the Selection Committee include:

For Vice Presidents of the Association (two years):

☐ **Harl P. Aldrich, Jr.,** '47, Senior Principal and President of Haley and Aldrich, Inc., Cambridge, Mass.

☐ **Charles K. Holmes, Jr.,** '49, Vice President of Coca Cola U.S.A., Atlanta, Ga.

☐ **George M. Keller,** '48, Vice President of Standard Oil Co. of California, San Francisco. (Mr. Keller will fill the one-year vacancy left by Mr. Moore's elevation to President.)

For Directors of the Association (two years):

☐ **Marvin C. Grossman,** '51, President of Electronics Marketing, Inc., Auburndale, Mass., representing District 1.

☐ **Emily V. Wade,** '45, Chairman of the State-Industry Sea Grant Council, Boston, representing District 2.

☐ **S. James Goldstein,** '46, Managing Partner of James Goldstein and Partners, Millburn, N.J., representing District 4.

☐ **Robert F. Calman,** S.M. '67, Chairman and Director of General Waterworks Corp., Philadelphia, representing District 5.

Mr. Moore has come "up through the ranks" to his leadership of the Association for 1978-79, beginning in 1964 as Treasurer of the M.I.T. Club of South Texas and Special Gifts Chairman for the Alumni Fund in the Houston-Beaumont area. Since then he has been President of the M.I.T. Club of South Texas, of which he continues as Director; Major Gifts Solicitor for the Alumni Fund; a member of the Club Advisory Board (1970-73) and of the Board of Directors (1975-77); and Vice President (1977-78). He's also Chairman of the M.I.T. Leadership Campaign in Houston, a member of the Corporation Development Committee; as President of the Association, he'll become ex-officio a member of the Corporation.

Mr. Moore's firm is a leading consultant to the petroleum and petrochemical industries on refining and processing; there is also a management science software group with an international clientele and a computing service firm. His M.I.T. degree was in chemical engineering.

Mr. Hotte, who has been Vice President of the Association since 1976 and a Director since 1973, has been a major figure in M.I.T. affairs in the midwest for more than a decade. In addition to his responsibilities for P.R. Mallory and Co., he is President of the Indianapolis Scientific and Engineering Foundation, Inc., Secretary-Treasurer of the Central States Rotary Youth Exchange Program, Inc., and a member of the President's Council of the American Management Associations.

Mr. Proctor has been active in alumni affairs almost continuously since his graduation in business and engineering administration, holding posts recently on the Board of Directors, the Alumni Fund Board, and the Club Advisory Board. His firm is the largest distributor of hydraulic and pneumatic power equipment in Ohio; he is a Trustee of Hiram College; and he teaches in the field of management at Case Western Reserve University and Cleveland State University.

Before taking her present post, Dr. Wick was for 20 years a member of the M.I.T. faculty in the Department of Nutrition and Food Science, and during this period she was identified with the interests of women students at the Institute as well as with important professional contributions in nutrition and chemistry. She's been a member of the Corporation's Visiting Committee on Student Affairs since 1974 and of the Board of Directors of the Alumni Association since 1976.

Five M.I.T. Men May Go to Space — N.A.S.A.'s Choices for the Shuttle

Five members of the M.I.T. community made national headlines this winter as the National Aeronautics and Space Administration zeroed in on the astronauts who will man the Space Shuttle beginning two years hence.

G. M. Keller

M. C. Grossman

E. V. Wade

S. J. Goldstein

R. F. Calman

☐ **Byron K. Lichtenberg,** a doctoral student working in biomedical engineering in the Man-Vehicle Laboratory in the Department of Aeronautics and Astronautics, is one of six finalists for the position of Payload Specialist aboard the first flight of the Spacelab in the Space Shuttle, set for 1980.

☐ **Terry J. Hart,** S.M. '69, Commander **Frederick H. Hauck,** S.M. '66, **Jeffrey A. Hoffman** of the Center for Space Research, and **Ronald E. McNair,** Ph.D. '77, are among 35 scientists and engineers selected to join N.A.S.A's Astronaut Corps for Space Shuttle service; they'll begin training at the Johnson Space Center in Houston on July 1.

The suspense will continue for Mr. Lichtenberg until sometime early this spring, when N.A.S.A will make its final selection for the Payload Specialist job. One of the lucky candidates will go into space to run experiments and operate instruments on the first Spacelab; the others will perform support and advisory roles in the Spacelab Control Center on the ground.

It was a good Christmas present, said Mr. Lichtenberg. He's been thinking about becoming an astronaut since his freshman and sophomore years at Brown. Then he spent four years in the Air Force flying F-4 fighters over Southeast Asia, and now he's working on the effects of weightlessness on the system by which humans tell where they are in relation to their surroundings — "whether you are up or down, sideways or upside down," he told Robert Cooke of the *Boston Globe.*

Of the four new astronauts, Commander Hauck was designated a Space Shuttle pilot; the other three are to be Mission Scientists, serving as flight engineers on the Shuttle as well as being in charge of onboard experiments.

Mr. Hart is now an engineer with Bell Telephone Laboratories, Long Valley, N.J.; he studied mechanical engineering at M.I.T., working with Professor David N. Wormley, '62, in system dynamics and control.

Commander Hauck came to M.I.T. as a naval officer to study nuclear engineering under Professor Michael J. Driscoll, Sc.D. '66. He is now a naval pilot stationed at Whitby Sound, Wash.

Dr. NcNair was an undergraduate student at North Carolina Agricultural and Technical University, Greensboro, N.C., when he first came to M.I.T. — as a participant in a student-faculty exchange with a consortium of predominantly black schools in the South. He liked what he saw, and after receiving his B.S. came to Cambridge for graduate work in the Spectroscopy Laboratory where he finished his doctorate under Professor Michael S. Feld a year ago. He's now with the Optical Physics Department of Hughes Research Laboratories, Malibu, Calif.

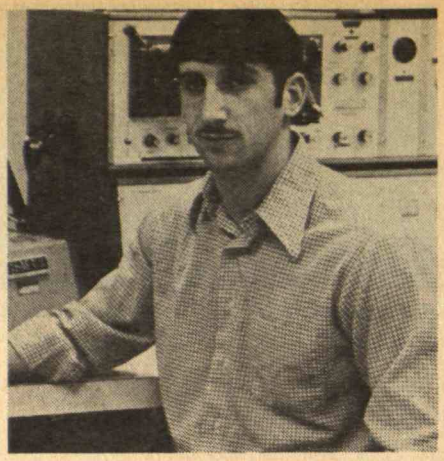
"He's one of the most imperturbable guys I've ever met," said a colleague about Dr. Hoffman, whose work is with the Cosmic Ray Group of the Center for Space Research. He came to M.I.T. in 1975, and he's now Project Scientist for a satellite experiment to measure x-ray emissions which approach the earth's atmosphere with energies in the 10-to-200-kilovolt range. Dr. Hoffman studied at Amherst and Harvard (Ph.D. 1971) and has since done postdoctoral work at the Smithsonian Astrophysical Observatory in Cambridge and the University of Leicester, England.

Alumni Fund Director

Stephen P. Denker, '59, Regional Director of the Alumni Association for New York City since 1975, is now Director of the Alumni Fund. He succeeds Frederick G. Lehmann, '51, who left M.I.T. nearly a year ago to take on major development responsibilities at Boston University.

Dr. Denker holds three degrees in electrical engineering from M.I.T. (S.M. '60, Ph.D. '63); he was Senior Engineer at the Schlumberger-Doll Research Center before joining the Alumni Association staff, and before that had been Assistant Professor of Electrical Engineering at Columbia University and Adjunct Professor at the University of New Haven.

Thomas H. Farquhar, '60, Chairman of the Alumni Fund Board, says that Dr. Denker's "knowledge of the Institute together with his experience in working with alumni will bring a unique and valued perspective to the Alumni Fund leadership."



The First Robert S. Faurot Scholar

The late Robert S. Faurot, '44, of Chicago and Winnetka, Ill., was a staunch supporter of M.I.T. and of his fraternity, Delta Kappa Epsilon — "one of the most active and enthusiastic leaders in M.I.T. alumni affairs," says John W. Barriger IV, '49.

Now, under Mr. Barriger's enthusiastic leadership, a group of 25 D.K.E. alumni have established a Robert S. Faurot D.K.E. Scholarship Fund with an initial goal of $50,000, and already funds are adequate to support the first Robert S. Faurot Scholar. Indeed, gifts and pledges of more than $30,000 were in hand as of June 30, 1977, according to Mr. Barriger.

Under terms of the Fund, preference will be given in awarding Faurot Scholarships to active members of the M.I.T. Chapter (Sigma Tau) of Delta Kappa Epsilon or sons and daughters of Sigma Tau Chapter alumni. The first Faurot Scholar fills the bill; he's Mark E. Taylor, '78 (above), a member and resident of D.K.E.

The picture shows Mr. Taylor in the electron microscope laboratory of the Department of Materials Science and Engineering, where he was taking the introductory course in electron microscopy during the fall term. Mr. Taylor is a major in the Department, concentrating especially on fracture mechanics and tensile testing. (Photo: John M. Grunsfeld, '80)

Individuals Noteworthy

Counselors: Officers, Directors, Advisers

William N. Johnston, '50, elected President of the American Bureau of Shipping, international ship classification society ... **Richard S. Engelbrecht,** Sc.D. '52, begins term as President of the Water Pollution Control Federation ... **Dana W. Mayo,** '52, to membership on the Board of Management of the Coblentz Society, a national organization of scientists in the field of infrared spectroscopy.

John E. Preschlack, '54, to the presidency of General Binding Corporation, Northbrook, Ill. ... **Clyde N. Baker, Jr.,** '54, appointed President of Soil Testing Services, Inc., Northbrook, Ill. ... **Morton L. Schultz,** '43, named President of A.C.L.I. Metal and Ore Co., New York, N.Y. ... **David P. Vanderscoff,** '66, proposed for election as President and a Director of Northern National Life Insurance Co. ... **Henry Schofield Noble,** '64, elected Vice President for trust administration and estate settlement at the First National Bank of Maryland's main office in Baltimore.

Robert S. Scher appointed Vice President, Engineering, at Teledyne Gurley, Troy, N.Y. ... **Philip D. Bush,** '39, named a group vice president of Kaiser Engineers, Inc. ... **Kenneth Whipple,** '58, elected as Executive Vice President, Insurance and Special Financing Operations, at the Ford Motor Credit Company, Dearborn, Mich. ... **Jonathan D. Shane,** '68, elected an assistant vice president at The Bank of New York.

Thomas E. Reed, '58, to direct the Biomass-Fuel program at the Solar Energy Research Institute, Colo. ... **Robert C. Seamans, Jr.,** Sc.D. '42, elected to the board of directors of Eli Lilly and Co., Indianapolis, Ind. ... **John E. MacNary,** '54, appointed Academic Dean at Mercy College of Detroit ... **James S. Meditch,** S.M. '57, named Professor and Chairman of the Department of Electrical Engineering at the University of Washington, Seattle ... **George A. Russell,** '47, named Chancellor of the University of Missouri's Kansas City campus.

Margaret L. A. MacVicar, '64, associate professor of physics at M.I.T., elected to membership on the Corporation of Boston's Museum of Science ... **Ronald A. Walter,** '63, appointed Deputy Chancellor, Administration, of the Board of Education, City of New York ... **Vincent L. McKusick,** '47, nominated as Chief Justice of the Maine Supreme Court ... **Clifford E. McLain,** '53, appointed Deputy Director of the Defense Civil Preparedness Agency, Washington, D.C.

M.I.T. Changes

Constance Parvey, the first woman ever ordained at Harvard Divinity School who has been Lutheran Chaplain at M.I.T. since 1973, has joined the World Council of Churches in Geneva, Switzerland; she's succeeded at M.I.T. by **Jessica Crist,** a student at Harvard Divinity School who has been vicar at M.I.T. since 1976.

John E. Newcomb, Jr., from Assistant Director for Administration to Associate Director of the Center for Advanced Engineering Study ... **Richard P. Marvel,** consultant on benefits programs, to Benefits Officer in the Office of Personnel Relations ... **Katharine C. Jones,** Staff Writer in the M.I.T. News Office, to the Writing Staff of the Resource Planning Office ...

Four Acquisition Editors named at the M.I.T. Press: **Treville Leger,** formerly with the School of Public Health, University of Michigan, in the life, health, and medical sciences; **Roger Conover,** publishing consultant, in architecture, urban and regional planning, and visual arts; **Rene Olivieri,**

formerly with Praeger Publishers, in management science, business, finance, and economics; and **Laurence Cohen,** for two years as editor at the Press, in physical sciences and mathematics.

Kudos: Awards, Honors, Citations

To **Angelo A. Lamola,** '61, chemist at Bell Telephone Laboratories, the Leo Hendrik Baekeland Award from the North Jersey Section of the American Chemical Society for "accomplishments in chemistry, characterized by initiative, creativeness, leadership, and perseverance." ... **Don J. Lapenas,** '69, appointed Assistant Professor in the Pathology Department, Emory University, Atlanta, Ga. ... To **Robert E. Hopkins,** '37, professor of Optics in the Institute of Optics at the University of Rochester's College of Engineering and Applied Science, the Society of Photo-Optical Instrumentation Engineers' Alan Gordon Memorial Award for 1977, in recognition of his "advancement of photographic instrumentation as a science of observation, recording, and measurement." ... To **Alan S. Michaels,** '44, Adjunct Professor of Chemical Engineering and Medicine at Stanford University, the 1977 Food, Pharmaceutical and Bioengineering Award of the American Institute of Chemical Engineering. To **Thomas H. Courtney,** '60, Professor of Metallurgical Engineering at Michigan Technological University, that school's 1977 Faculty Research Award for outstanding dedication to research and contributions to society and science ... To **Wesley H. Loomis III,** '35, President of General Telephone Directory Co., the Pioneering Spirit Award of the Independent Telephone Pioneer Association for his outstanding contributions to the telecommunications industry ... To **John G. Borger,** '34, Vice President and Chief Engineer of Pan American World Airways, the 1977 Nuts and Bolts Award of the Engineering and Maintenance Forum of the Air Transport Association, recognizing outstanding contributions to airline engineering and maintenance.

Roger B. Hickler, '46, named Lamar Soutter Distinguished Professor of Medicine and University Professor at the University of Massachusetts Medical School ... **Ivan Sutherland,** Ph.D. '63, appointed to the Fletcher Jones Chair in Computer Science, and **Alan Perlis,** Ph.D. '49, appointed to the Gordon and Betty Moore Professorship in Engineering; both at Caltech ... To **Chin-Chung Hsin,** Ph.D. '76, the "William E. Jackson Award" from the Radio Technical Commission for Aeronautics ... **C. Fayette Taylor,** '29, elected a Fellow of the Society of Automotive Engineers ... **George M. Walsh,** '60, elected a Fellow of the Acoustical Society of America.

Bernard P. Gregory, 1919-1977: Statesman of French Science

Bernard P. Gregory, Ph.D. '50, former Director of the European Center for Nuclear Research and of the Centre National de la Recherche Scientifique, died in France on Christmas Day, 1977. He was 58.

Professor Victor F. Weisskopf of M.I.T., who preceded Dr. Gregory as Director of C.E.R.N., described him as a "scientific statesman," a man of "impeccably good taste in science." He had made important contributions to particle physics and to the development of equipment for high-energy research.

Dr. Gregory came to M.I.T. from the Ecole Polytechnique, Paris, from which he graduated in 1945. He returned to Paris five years later with his Ph.D. from the Institute, earned while studying cosmic rays under Professor Bruno Rossi in the Department of Physics, and immediately established an important cosmic ray research program at his alma mater. Dr. Gregory served as Scientific Director and — from 1966 to 1970 — Director of C.E.R.N., and then was Director of the Physics Laboratory at the Ecole Polytechnique until 1973, when he was asked to head France's C.N.R.S.

James P. Barber, 1951-1978

James P. Barber, a doctoral candidate in the Department of Political Science, died on January 10 in Children's Hospital, Boston; he was 27.

Mr. Barber came to M.I.T. in 1972 after completing undergraduate studies at Harvard; he was severely physically handicapped, and death resulted from influenza and pneumonia complicated by the effects of his handicap. Mr. Barber had visited the U.S.S.R. in connection with his M.I.T. research in 1976, and he was widely admired by fellow students and teachers for academic accomplishments and personal courage.

Deceased

Walter B. Wyman, '06; August 30, 1960; Crown Point, Crown Point, N.Y.
Guy E. Boynton, '07; January 7, 1978; 2199 N.E. 123rd St., Miami, Fla.
Mrs. Warren Hastings, '07; October 22, 1977; 33 Edison Ave., Ogdensburg, N.J.
Keyes C. Gaynor, '09; August 28, 1977; 1701 West 25th, Sioux City, Iowa
Robert F. Burnett, '10; December 13, 1977; R.D. #2, Oneonta, N.Y.
Russell Hastings, '10; January 22, 1978; 35 Appleton St., Cambridge, Mass.
Albert K. Huckins, '10; April 30, 1976; 13 Canterberry Hill Rd., Topsfield, Mass.
Mrs. William J. O'Hearn, '10; 21 5th Ave., Scituate, Mass.
Mrs. William A. Canaday, '12; December 14, 1974; 146 De Leon Rd., De Bary, Fla.
Mrs. Thomas A. O'Reilly, '13; December 18, 1975; 5274 Westminster St., St. Louis, Mo.
Joseph N. Paul, '13; September 8, 1977; St. Joseph's Manor, 6448 Main St., Rm. 452, Trumbull, Conn.
Louis B. Black, '14; September, 1976; 10 Avoca Ave., Toronto, Ontario, Canada
Harold R. Crowell, '15; January 26, 1978;

4124 Dundee Dr., Los Angeles, Calif.
Mrs. Hiram Y. Waterhouse, '15; March 20, 1976; P.O. Box 726, Kennebunkport, Maine
Herbert J. Gilkey, '16; August 13, 1976
Frank N. Crane, '17; December 16, 1977; P.O. Box 3462, Carmel, Calif.
Augustus P. Farnsworth, '17; October 6, 1977; King Road, Etna, N.H.
Ernest L. Schwartz, '19; January 1, 1978; Box 86, Franklin, N.H.
Robert B. Frost, '21; October 30, 1977; 1234 N. 19th St., Allentown, Penn.
Joseph G. Kaufman, '21; February 15, 1973; 16300 W. 9 Mile Rd., #915, Southfield, Mich.
Robert P. Kite, '21; November 2, 1977; 160 Valley Stream Rd., Larchmont, N.Y.
Henry M. Lane, '21; December 27, 1977; 350 Lake St., Belmont, Mass.
Paul H. Rutherford, '21; July 13, 1977; 7 Valley Rd., Nahant, Mass.
George B. Weatherbee, '21; October 6, 1977; 45 Eastern Prom. #7-H, Portland, Maine
Mrs. H. Langdon Haltermann, '22; October 5, 1975
Willard B. Purinton, '22; November, 1977; 78 Winthrop St., Augusta, Maine
William W. Russell, '22; January 2, 1978; 1318 Beacon St., Brookline, Mass.
Dean K. Worcester, '22; October 1, 1977; 520 E. 86th St., New York, N.Y.
William W. Bray, '23; July 17, 1977; 3600 Galt Ocean Dr., Fort Lauderdale, Fla.
Charles W. Cristal, '23; November 25, 1976; 20676 Fairmount Blvd., Cleveland, Ohio
Randall W. Ludt, '23; 1968; 1208 N. Foster, Lansing, Mich.
Charles H. Wardwell, '24; December 21, 1977; 29 Water St., South Dartmouth, Mass.
George W. G. Brooker, '26; February, 1977; Factory Mutual Eng., 2850 Golf Rd., Rolling Meadows, Ill.
Joseph B. Merrick, '26; September 26, 1977; Y.M.C.A., 160 Broad St., Providence, R.I.
Jacob C. Muskin, '27; 1977; 1321 Nelson Ct., Hewlett, N.Y.
Ernest Santangini, '28; October 12, 1977.
Arthur W. Griffith, '30; August 11, 1977; 112 Dan Miler Ln., Summerville, S.C.
John J. Molloy, '30; January 2, 1978; 39 Pine St., Medfield, Mass.
Kendall Clark, '31; January 29, 1978; 4 Linden Rd., Poughkeepsie, N.Y.
Frederick E. Mader, '32; October, 1977; 15 Park View Ln., Shrewsbury, Mass.
Robert K. Kepner, '34; 1975; 50 W. Shore Rd., Denrick, N.J.
John A. Valtz, '36; January 19, 1978; 731 Lynnfield St., Lynn, Mass.
Herman Schaevitz, '38; September 5, 1977
Jane H. Hatter, '40; December 19, 1974; Main St., Harwich, Mass.
John W. Brumbaugh, '42; January 6, 1978; 454 Knollwood Terr., Westfield, N.J.
Alice R. Knox, '43; December 4, 1976
C. Frederick Broderson, '47; December 10, 1977; 310 Bryant Ave., Cincinnati, Ohio
Roland E. Derby, Jr., '49; December 25, 1977; R.F.D. #1 Sherburne Ave., Tyngsboro, Mass.
Lloyd H. Shaffer, '49; January 15, 1978; 156 Intervale Rd., Stamford, Conn.
Bernard P. Gregory, '50; December 25, 1977; Frechambant, Elancourt Seine et Oise, France
Robert O. Dobbs, '52; August 23, 1969; 3965 Guebeville Rd., Santa Rosa, Calif.
John H. Hartnett, '55; December 23, 1977; 700 Ashby Dr., Waynesboro, Va.
Joseph M. Williams, '56; January 25, 1978; 357 Hale St., Prides Crossing, Mass.
Allen B. Chertoff, '59; January 25, 1978; 185 West End Ave., New York, N.Y.
John E. Ward, '74; January 11, 1978; 128 N. Woodcrest Dr., Melrose, Mass.

coupling activity that attempts to match available technology to the prospective user's needs. The Atomic Energy Commission had a special problem of classified nuclear information; it established professional referees at each contractor site and A.E.C. lab to evaluate reports for declassification. A formal Industrial Cooperation Program was established to provide active information dissemination through seminars, facility tours, special demonstrations, and also to provide a mechanism for technical assistance to industry in the use of nuclear technology. The A.E.C. even performed work for private industry when this facilitated the process of technology transfer.

N.A.S.A., through its Technology Utilization Program, has made a significant though nearly fruitless effort since 1962 to transfer space research results into commercial use. Going beyond its information dissemination activities described earlier, N.A.S.A. employed in-house staff and technical consulting firms to prepare "Tech Briefs" of research results that are judged to have promising innovation potential.

As a further step toward enhancing commercialization of its research output, N.A.S.A. established ten Regional Dissemination Centers to try to bring space research outcomes to bear on industrial technology requirements in different areas of the U.S. Their frustrated attempts led to cancellation of most of the centers, probably because of the mismatch between technology and user needs. Said one tactful researcher of the N.A.S.A. Technology Utilization Program, "The Technology Utilization Program appears to be providing a large number of answers to unrecognized industrial needs." But at least N.A.S.A., unlike most federal agencies, tried to bring its technology in contact with possible industrial users, with an applications engineer to attempt the coupling.

Experts in the Field

The most ambitious and clearly most successful government effort at research utilization is the Cooperative Extension Service of the Department of Agriculture. The program is based upon a national network of U.S.D.A. field agents at the county level, averaging three agents per county but ranging from one up to 20 or even more in agriculturally intensive regions of the country. The county agent is, in effect, a salesperson of new technology, drawing from research results at the national level or in his local area, using U.S.D.A. field stations or pilot research farms as demonstration sites. The county agent creates awareness of new research by direct personal contact with all the farmers, is usually well qualified and locally respected, and develops personal rapport with local farmers over years of working with them. State land grant colleges are the primary backup for expertise and additional problem-solving research and development, and the farmer is not charged for these helpful U.S.D.A. services.

Incentives for Utilization

Patent incentives, direct financial stimuli, and other incentive approaches have also been used by the federal government. Profit motivations lead most industrial firms to desire, sometimes to require, patent protection before they will attempt commercial exploitation of a research result. The A.E.C. discouraged exploitation by keeping ownership on all its patented research outcomes. In contrast, the D.O.D. cedes to its industrial contractors all commercial rights to research results generated under contract. N.A.S.A. hedges on this score and reserves the right to keep patent rights, while claiming it will probably turn over exclusive patent rights to industry in most cases.

Utilization incentives in the areas of patent policy, seed financing, and other activities are now being subjected to experimental study by a relatively new program conducted by the National Bureau of Standards — the Experimental Technology Incentives Program. The E.T.I.P. looks promising in concept, but is too small to have much effect.

It is striking that all these governmental programs start to encourage utilization of research only after the research and development results have been generated. Yet the most effective industrial approaches to increased research utilization begin much earlier in the innovation process — as far back as when ideas are generated and selected for development — *E.B.R., A.L.F.*

change relies on transmitting information to the people whose behavior is to change, and expecting the irrefutable logic of the argument to motivate the change. The generous funds and enormous activity behind the government's immense information storage and retrieval mechanisms can be placed on the doorstep of this essential (but we believe faulty) assumption. While these mechanisms are the prime activity of most federal agencies examined by the authors, agriculture excepted *(see above)*, industry and researchers investigating the process of change have been convinced for years that strategies that rely on purely rational components are doomed to failure. New information, the research tells us, can at best create awareness. New information produces no commitment to an opportunity, no skills to exploit the opportunity, nor any conviction as to the benefits of exploiting it. All of these are necessary for eventual trial and adoption of an innovation, and the willingness to entertain change.

☐ *Responding to technological opportunities.* An innovation in response to a market need has a greater probability of utilization than one generated primarily by a technological opportunity. The general failure of applications engineering programs — particularly in federal agencies — supports this finding. Remember, the shift in objectives of industrial research organizations from technical problem-solvers to "market-need fillers" was motivated by the need to achieve better utilization of their research results.

The utilized innovations originating from "technology push" are in the minority and are characterized by market-oriented adaptation expenses far in excess of initial expectations. Some causes contributing to the poor utilization record of "technology-push" innovations are: the intended user recognizes neither the need for the innovation nor its benefits; the potential user does not understand the innovation; adapting the innovation to suit user requirements is prohibitively expensive; the technology advocate is often perceived to be taking the "I know what is good for you" attitude.

☐ *Lack of clear market definition and familiarity.* The

The customer who is involved in the development of the innovation will have a strong conviction about the value of the results.

relative success of person-to-person technology transfer is based upon a growing rapport with the user which, very importantly, provides the developer with opportunities for contact and better understanding of the user's needs.

There is seldom a pure technical decision in research and development. We emphasize the requirement for a clear understanding of the needs, perceived and real, of the target user prior to development. No matter how early in the development cycle of the innovation, each decision has possible consequences for the form, usefulness, cost, and appeal of the results in the marketplace. Accordingly, it is necessary to have sufficient information about the market soon after the initial idea is formulated.

These three points strongly suggest steps that can increase the probability of research utilization: generator-to-user contact and information sharing; research based on market need; and clear market identification and familiarity. These steps argue for changes in how a research project is executed as well as for changes in utilization strategies for companies and government agencies seeking to increase the probability of their research results being utilized.

☐ *Significant user involvement.* The major hurdle to utilization of research results is the lack of conviction on the part of the customer that adoption of something new is worth the cost of change. However, the customer who is involved in the development of the innovation will have a strong conviction about the value of the results. Industry has used personnel transfers, joint undertakings, and formal and informal contacts among groups to stimulate this involvement.

The argument that users are not sufficiently sophisticated to participate in these activities ignores two points. The prime problem to be solved is a user problem, not a technical problem: the user has the best information regarding the acceptability of the solution. Studies in many diverse fields — education, scientific instrumentation, fire services, and semiconductor equipment — have documented the significant amount of user-generated innovations.

We have been involved in several episodes where a user who has been involved in the research becomes the strongest advocate for its utilization to other potential users. Each organization, after the research project was completed, became "salesperson" for the technology. Accordingly, we feel strongly that appropriate attention to the characteristics of the organization and personnel who participate, as noted previously, and meaningful continual mechanisms for involvement of the user, can help federal agencies and industrial organizations significantly enhance their utilization records.

☐ *Responding to market needs.* "Market research," broadly defined, is an essential part of an effective research planning process. An examination for felt needs and the types of acceptable solutions (in terms of economic, technological, aesthetic and consumer values criteria) can provide the information that targets a research effort with a greater probability of producing utilized results than one without such information. Consumer involvement in the research process can help to ensure the continued relevance of the output to market needs.

☐ *Providing the appropriate mix and balance of skills.*

For effective research utilization to occur, a very diverse set of activities must be carried out, usually by people with different skills and orientation. Industrial organizations have recognized the multiple skills necessary and have brought marketing and management personnel and scientists and engineers with different orientations into the research and development organization.

The absence of key people with skills to perform the necessary tasks can result in characteristic failures in the innovation process, reducing the chances for successful utilization.

Achieving effective utilization of research requires careful planning, staffing, and execution of the research effort to take into account — from the beginning — what is necessary to facilitate utilization of the results. While no practice guarantees utilization of the results, the approaches examined here increase the probability that the research output will be adopted by its target users.

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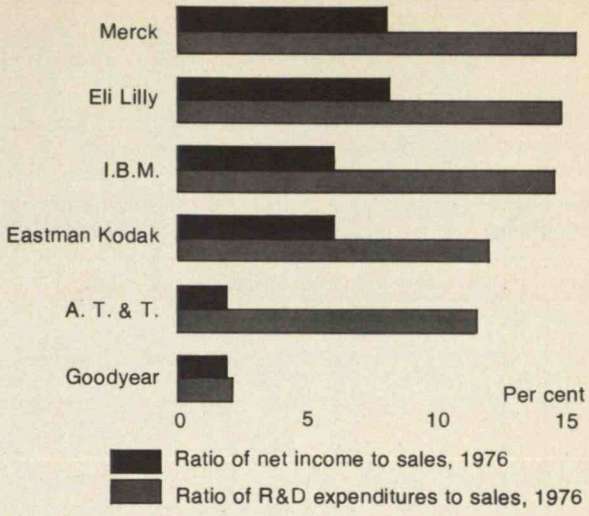
Edward B. Roberts holds four degrees from M.I.T. — in electrical engineering (S.B. and S.M., 1958), management (S.M., 1960), and economics (Ph.D., 1962). He has been a member of the Sloan School faculty specializing in system dynamics, entrepreneurship, the management of research and development, and more recently, health care management. He is co-founder and president of Pugh-Roberts Associates, Inc., management consultants, and he has worked for the success of several technology-based new enterprises as a member of their board of directors. This article is based on a review of research utilization approaches that Professor Roberts and Dr. Frohman prepared at the request of a panel of the National Academy of Sciences.

Alan L. Frohman received his B.A. in psychology from the University of Rochester, and S.M. and Ph.D. from the M.I.T. Sloan School of Management. He then became senior consultant with Pugh-Roberts Associates, Inc., where he worked with a variety of North American corporations on problems of research and development management and organizational development. More recently, Dr. Frohman has returned to academia with a faculty position at Boston University School of Management, where he is Adjunct Associate Professor of Organizational Behavior, to continue research and teaching in the management of innovation.



The heaviest spenders in research and development are among the most profitable of U.S. firms. Data from Technical Insights, Inc., on the 50 firms making largest investments in research and development in 1976 shows a direct correlation between income and research and development expenditures as ratios to sales. Goodyear, near the bottom in research and development investments, is typically low in net income.

Corporate Growth, R & D, and the Gap Between

A funny thing seems to happen between research and development and corporate results. While research and development expenditures correlate well with company profitability, the correlation between profitability and new product introduction — supposedly the goal of successful research and development — is far less good.

Merck and Co.'s investment in research and development in 1976 was 8.2 per cent of sales — one of the highest ratios among the 50 U.S. companies whose 1976 research and development expenditures were highest. Merck was the most profitable company among the 50, with income of 15.3 per cent of sales.

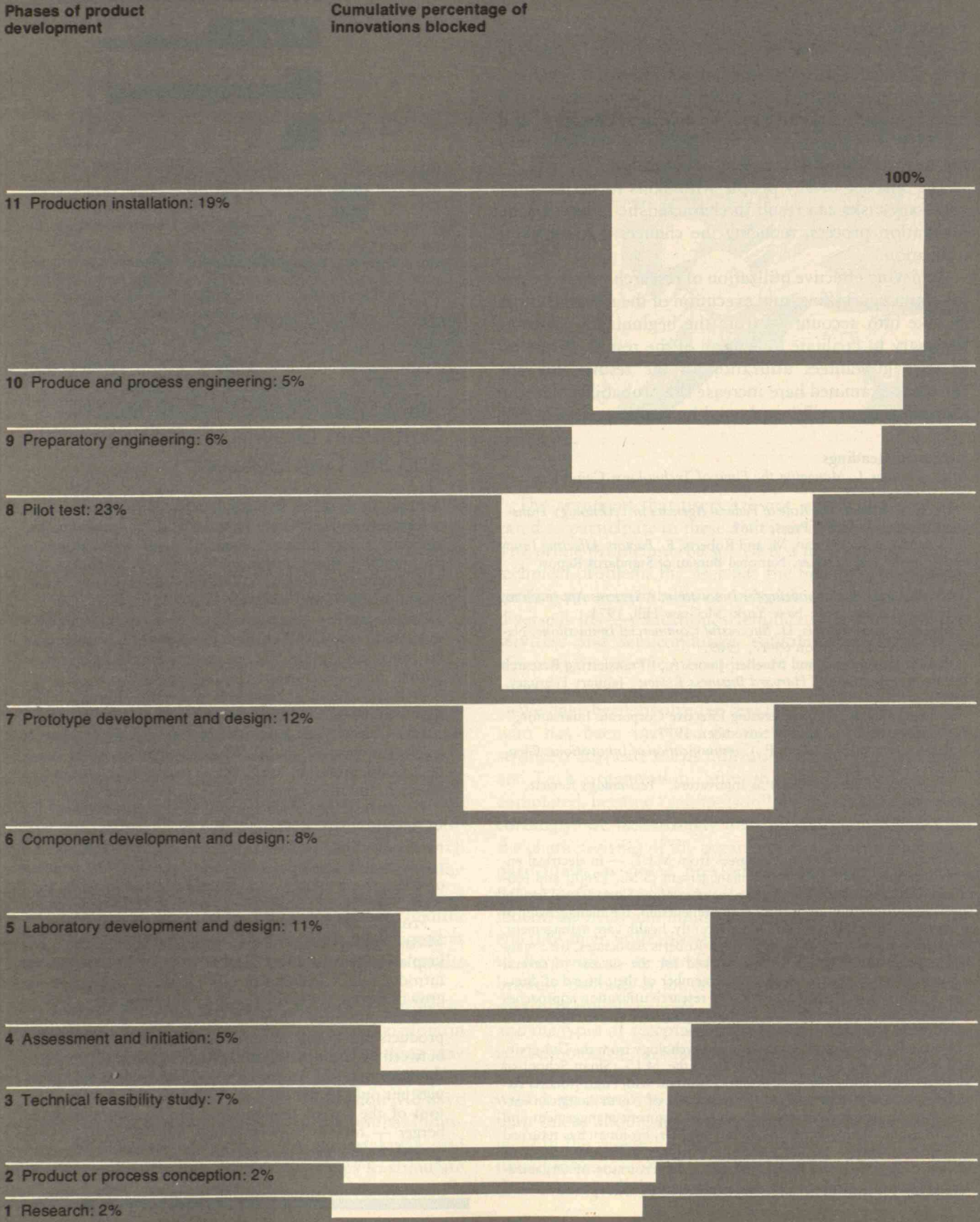
After Merck, the next five most profitable companies on the list were A.T.&.T., Dow, Eastman Kodak, I.B.M., and Lilly; these six companies' average investment in research and development was 5.7 per cent of sales.

In contrast, the six least profitable companies on the list — Boeing, Chrysler, Goodyear, McDonnell-Douglas, Signal Companies, and United Technologies — averaged a research-and-development investment of only 3.5 per cent of sales. These figures come from Technical Insights, Inc., New-York-based publisher of *Inside R & D* newsletter.

From Marketing Development consultants of Concord, Mass., comes the evidence of frustration in the marketplace: there is only a modest correlation between the introduction of "significant new products" and corporate growth during the three-year period before May, 1975.

North American Phillips is the classic case: 139 new products rated as significant" by Marketing Development between 1972 and 1975, and 122 per cent sales growth in the same period. Next in line: 3M Co. — 120 new products but only 48 per cent growth. And look near the bottom of the list of new-product producers for Schlumberger — only 51 new products but 98 per cent sales growth in the three-year period. — *J.M.*

Innovaha!tion



Why Innovations Fail

Countless innovations fail because no one wants or needs them. But too often good ideas are lost to poor management.

Sumner Myers
Eldon E. Sweezy
Institute of Public Administration

Chart at left: Each phase of product development sees a few more potential new products expire. A remarkable 84 per cent, however, continue to be funded well beyond the relatively inexpensive feasibility and assessment stages.

"It was," said William Holden as the business executive in the movie *Executive Suite*, "just one attempt in a hundred to make one improvement in a hundred." The "it" was a new molding process which would presumably have improved the Tredway Corp.'s furniture line. Unfortunately, a key production test failed and the innovation was delayed. A failure of technology? Perhaps. But Holden felt that the test might have succeeded had he been there to make a key management decision rather than cooling his heels in the board room waiting for a hastily called meeting. A failure of management, then? Either way it would have been called an innovation failure in the real industrial world.

The failure rate for industrial innovations is high. One study found that although the rate varies among industries and companies, on the average "it takes some 58 ideas to yield one successful new product." The vast majority of ideas fail at the outset: only 10 or 12 per cent of the ideas submitted for initial screening and analysis enter the development pipeline toward commercialization.

What does this high failure rate mean? Is it simply evidence that the competitive battle ensures the survival of only the fittest innovations? Or does it represent a waste of potentially useful products and therefore of scarce industrial resources? Whatever the hypothesis, such a high rate of failure calls for an effort to understand its causes. With that understanding, management can better steer its product innovations around the barriers to successful commercialization.

We conducted a study of 200 innovations that passed initial screenings but failed after entering the commercialization pipeline for the Denver Research Institute, under the auspices of the National Science Foundation. Our results confirmed some of managements' fondly held convictions, but exploded some others:

☐ The greatest risk is still the marketplace. Uncontrollable market factors scuttle more new products and processes than anything else — 27.5 per cent of the innovations studied. Yet management often plunges ahead without trying hard enough to minimize that risk.

☐ Limited sales potential blocked 16 per cent of the new products studied. Better research to identify new markets would help here, as would a stronger national economy. In a sagging economy, innovations start slowly and succeed with difficulty — even with good market research, shrewd management, and all the technology in the world. A booming economy, on the other hand, spurs innovation by generating the new demand that drives the innovation process.

☐ The inability to find buyers for something developed in the public interest — a large market problem that management is often criticized for avoiding — blocked 10 per cent of the innovations surveyed. Even tough managers sometimes let philanthropy overwhelm good sense in choosing which innovation to develop.

☐ Poor management accounted for 23.5 per cent of the innovations that were cancelled, shelved, or inordinately delayed. Not surprising perhaps, but disturbing — over one-third of the management errors involved market factors which management could have controlled.

Management Errors — Too Many "Goofs"

Whether pulled by the market or not, too many innovations fail because of management errors that seem preventable. And too many of these errors are simply "goofs" — forgetting to do the obvious. For example, one firm spent a good deal of money to develop a special welding torch for use in repairing automobile bodies. Not one was sold. Puzzled, management representatives visited potential customers to find out why. Only then did they learn the torch couldn't be used on the auto body with the upholstery already in place. The torch would have been a fire hazard. Obviously, management could have avoided this failure had it checked with its potential customers before developing such a product.

In sum, failures of management and marketing together accounted for half of the 200 innovations in the sample that faltered or failed. Yet, we also find from the data that management does a good initial job of screening many innovations that would obviously fail later on:

☐ Only 9 per cent of the innovations studied were stopped in the marketplace because the company was unable to find a market for them. Fragmented markets undoubtedly pose a larger problem, but they usually surface at the project selection stage when management can simply reject the proposed innovation.

☐ About 7 per cent of the innovations were blocked by competition. Here, too, if management sees an overcrowded market ahead, the proposed innovation is rejected before it is developed.

☐ Management also tends to reject would-be products or processes obviously susceptible to patent and antitrust problems. Factors arising from patent and antitrust laws accounted for stopping only 3 and 2.5 per cent (respectively) of the innovations studied. In short, management takes a most conservative approach which usually avoids problems that can be spotted at the outset.

Management succeeds in anticipating some types of market and legal problems, but its performance with respect to capital and technology is poor. Some 11.5 per cent of our sample were adversely affected by technology, and one-quarter of these innovations stopped for technological reasons were, in effect, "scooped" by another company's superior technical approach which management had failed to anticipate.

Money was a problem for companies of all sizes, but to less of an extent than expected: management's estimates of the capital required to complete the innovation process are usually too low; lack of capital halted 15.5 per cent of the blocked innovations. The costs of pilot plant, installation, and changeover often overrun — so often that overruns accounted for almost one-third of the innovations blocked for capital-related reasons.

Where the Trouble Starts

Innovations are weeded out little by little until they enter the pilot test stage, where many more of them falter or fail entirely *(see page 40)*. Almost three quarters of the innovations entering the development pipeline made it all the way into pilot test before management decided to call a halt. Indeed, more innovations — 23 per cent — fail in the pilot test stage than in any other. The second largest number of innovations — 19 per cent — are stopped in the final and most expensive phase, production installation. Management must seriously consider the cost implications for companies when innovations pass the inexpensive early stages only to expire later. It is remarkable that 84 per cent of all innovations in the sample continued to be funded beyond the low-cost phases of assessment and initiation — the stages where commonsense dictates that products less likely to succeed should be screened out.

Learning from Failure

To learn how, where, and why innovations actually run into trouble, we asked management officials who were directly involved in specific failures to tell us the story of what happened. Our respondents generally were the corporation presidents, vice presidents in charge of research and development, or heads of research and development divisions within the corporations attempting the innovations who personally made the tough decisions to cancel, shelve, or delay the innovations in question.

Memories were surprisingly sharp on the details of what happened, even down to the fine points. Once an innovation is funded, the decision to drop it seems sufficiently wrenching to be remembered by those involved. In any event, while managers tended to be hazy about how an innovation was started, they were very clear about how it ended.

Our respondents' stories were straightforward enough to be classified easily into the five broad categories: market, management, capital, technology, and laws and regulations. They also yielded additional lessons for innovators. For example:

☐ *The search for the capital necessary to develop an innovation through the marketing phase may end in a "Catch 22."* One company developed a new diagnostic x-ray machine with government research and development funding. Before the machine could be produced in marketable form, extensive field trials were required. Government funds could not be used to conduct such trials, and other possible suppliers of capital were unresponsive because marketability had not been demonstrated by available data — which could be obtained only through field tests. (The barrier in this case was classified as *capital*.)

☐ *A superior competing technological approach may cancel the development of a new product or process.* A major metals company undertook the development of vacuum deposition of aluminum as a substitute for tin plate in cans and other containers. The process was developed through completion of a full-scale, high-speed production line — which never went into full production because the firm discovered that chrome plate was much cheaper and just as good. The entire production line for aluminum production remains mothballed by the firm. (The barrier in this case was classified as *technology*.)

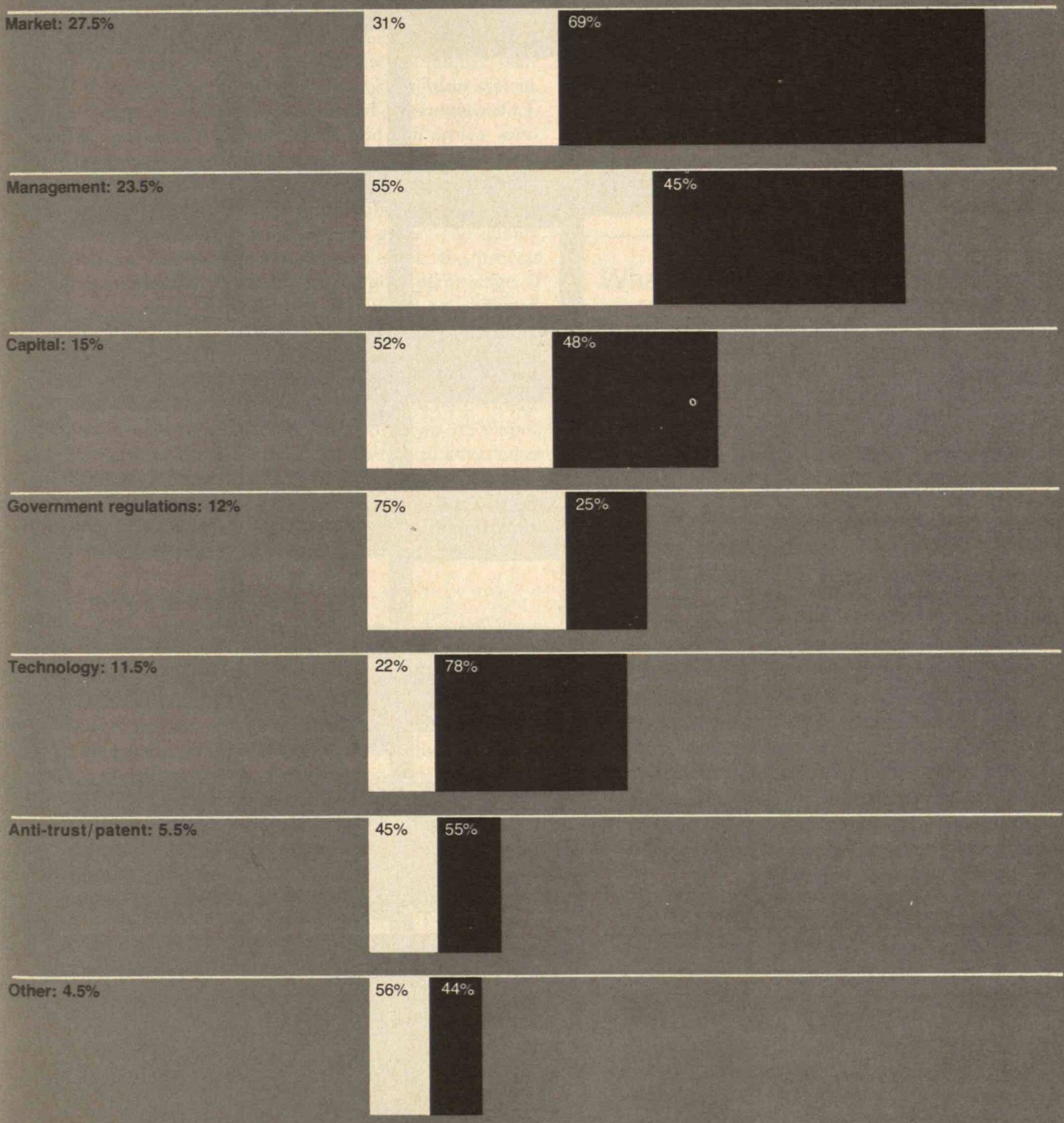
☐ *The public interest often fails to express itself in the marketplace.* A major supplier of automobile components tried to introduce an anti-skid brake-control system for

Obstacles to successful commercialization

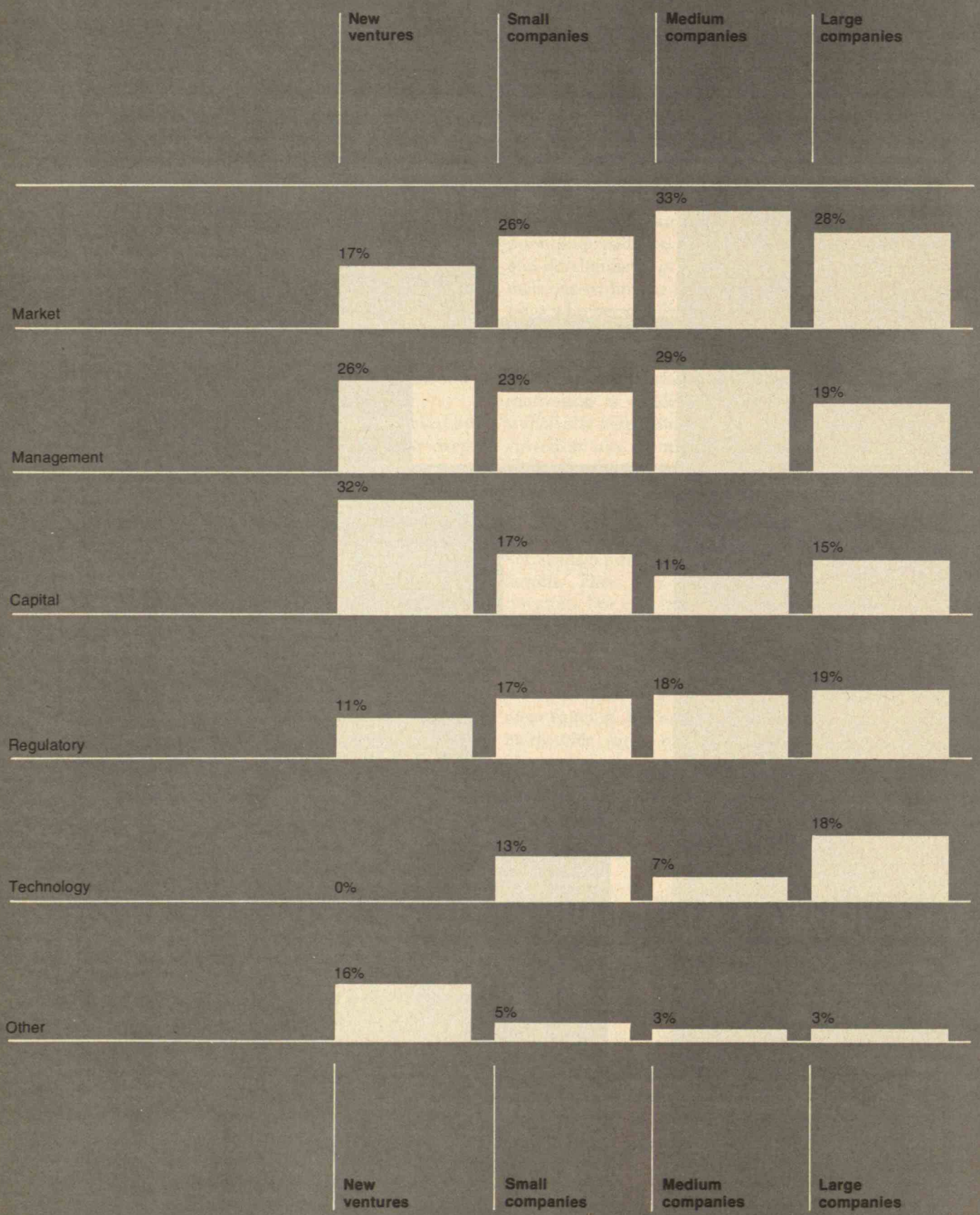
"Still good" innovations

"Not good" innovations

The study of 200 innovations that failed reveals that many (the "not good" innovations) deserved to fail, a quarter of them were "still good" innovations, scuttled either by poor management, or by uncontrollable market, monetary, or regulatory factors.



The size of the fostering company can often predict the types of blocks to which an innovation will fall prey (see box, facing page).



passenger vehicles. The firm carried the project almost to the production phase but was unable to arouse enough public interest in voluntary adoption of the system to market it. (The barrier in this case was classified as *market.*)

☐ *Lack of technical capabilities in the staff of a firm may delay the solution of a technical problem for so long that a project loses its competitive advantage by the time it becomes marketable.* One firm developed some prototype engines using a piezo-electric ignition system but sold the rights to the system to another firm. The second firm had to solve some technical (noise and time-delay) problems before the system could be marketed. Because the lack of technical expertise ate into time, when the system was finally ready, the market was no longer exclusive; the opportunity to achieve economies through large-scale production techniques was lost. The product was withdrawn after the costly, two-year delay; new techniques were used to develop an acceptable low-cost ignition system. (The barrier in this case was classified as *management.*)

☐ *The assumption that an innovation will violate anti-trust regulations may prevent its development.* A medium-sized steel company developed a process for reclaiming zinc and iron by processing pelletized dust recovered from scrubbers of exhaust gases. The quality and quantity of the zinc by-product made the process look economically promising at the pilot-plant stage, if sufficient tonnage of reclaimed dust could be obtained. This would require access to more than one plant. When a joint venture with other steel companies was explored as a feasible basis for full-scale operation, however, the objection was raised that such a venture would violate anti-trust laws. The process has not been developed further in spite of its economic and ecological advantages — although the requisite joint venture *might or might not* violate antitrust laws: the Department of Justice will not provide this information until the process is in operation! (The barrier in this case was classified as *regulatory.*)

How to Save the Good Ones

The process of innovation is Darwinian, and not all innovations deserve to survive. Our respondents, therefore, were asked to judge, in a broad economic sense, whether the innovation was still "good" or "not good" in view of the events that led to its blocking. For example, although management's judgments were necessarily subjective, they were strong; when several respondents commented on the same innovation, they almost always agreed as to whether the innovation was "good" or "not good."

Ninety-two of the 200 innovations that faltered were judged by management to be ideas well worth saving. (All the innovations mentioned above were judged to be good ones, except for the two blocked either by technology or market factors.) To save the promising innovations, management should, of course, pay more attention to factors that block "good" rather than "not good" innovations. So it's important to note that management error and government regulations accounted for 28 and 20 per cent, respectively, of the 92 "good" innovations that ran into trouble. The data clearly indicate:

☐ Managers can save many good innovations by doing a better job of managing, particularly by asking the right questions at the right time.

☐ Managers should press government to overhaul the regulatory processes that block so many good innovations. Government administrators could ease this problem without necessarily addressing the substantive issues of regulation — although the latter may be most desirable. For example, the government could provide advisory guidance concerning the applicability of a regulation and the means by which the items in question could be adapted to meet regulatory requirements. In the absence of such advice, firms often discover too late that their innovations must be adapted expensively to meet regulatory requirements which had been "incorrectly" interpreted.

The data also show that few, if any, innovations might be saved by loosening the federal government's stringent standards, tough tests, etc. — most of which, in any event, are meant in the public interest. The obvious conclusion is that management should not waste its time lobbying for less stringent regulations.

While managers may hope for the unsnarling of the regulatory process and companies may lobby for simpler

What To Expect in Your Company

The innovations of different size companies tend to encounter somewhat different patterns of obstacles. For example, we see in the facing diagram that:

☐ *New ventures,* companies formed specifically to develop and market a particular new product, are highly vulnerable to capital problems. They run out of money before they run out of market opportunities. While their technologies raise no great problems, their unseasoned managements tend to err relatively often. New ventures, however, avoid both regulatory and market obstacles more readily than other companies, regardless of size.

☐ *Small companies* (under 500) have relatively fewer management problems than either new ventures or medium-sized companies. Their trouble from regulatory, market and technology obstacles is average.

☐ *Medium-sized companies* (500 to 2,500) encounter a disproportionate share of management problems. Apparently, these companies are too big for innovations to command the individual attention of top management, but too small to hire the kind of specialized management that innovation needs. Capital for innovations is a somewhat less important obstacle for a medium-sized company than it is for either large or small companies and, of course, much less than new ventures. Regulatory, marketing and technology obstacles are unexceptional.

☐ *Large companies* (2,500 plus) are least troubled by management problems. Their regulatory and market obstacles are similar to those of medium and small companies. Technology tends to be a relatively greater problem for the large companies, who become involved in riskier technical efforts than their smaller counterparts.

These data represent the actual experience of 200 technological innovations that faltered or failed in 81 companies drawn from 11 producer-good industries. While the companies were not selected to be a sample of industry as a whole, the patterns of failure are probably similar across the board. — *S.M., E.S.*

controls, a more pressing task for industry is to examine its own practices. These are immediately controllable. Industrial managers who do this will see obvious mistakes that could have been avoided by asking seemingly trivial questions. Does the innovation have a clearly designated manager? Are staff capabilities matched to the innovation tasks? Is the cost analysis adequate? And so on. Obvious as these questions are, management often forgets to ask them until it is too late.

The real problem is to design and adopt a system that forces management to ask the right questions at the right time. Of the 200 cases in the study, 42 per cent might have benefitted from a systematic stepped technique of continuous evaluation.

Management systems with built-in forced questioning would perform two major functions:

☐ They remind management to do the things that are so obvious that they are easily forgotten.

☐ They force an appraisal of the assumptions and ideologies that underlie every innovation. It is a rare organization whose commonly held beliefs need never be examined, and such scrutiny is the task of management.

Another good way to get the right questions asked at the right time is to broaden the membership of product development teams to include people from outside the organization. Whatever their technical qualifications, such people may be perceptive enough to sense what's missing or assumed, and disinterested enough to blow the whistle on innovations which are going to falter or fail.

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Sumner Myers graduated from M.I.T. in 1948. He is now Director of Technology and Transportation for the Institute of Public Administration. His "hands on" experience with the innovation process includes work as Production Analyst, Chief Industrial Engineer, and Plant Manager. He began his studies of the innovation process with an N.S.F.-sponsored analysis of 600 commercially successful innovations. This led to work on innovations in transportation and energy for D.O.T. and D.O.E., respectively. Mr. Myers' current focus at I.P.A. is on the "public use of private interests" in furthering socially desirable technologies.

Eldon E. Sweezy received his Bachelor of Science from Oklahoma State University, and his M.A. from the American University. As Army Research and Study Fellow, he spent 1957-58 at M.I.T. as a Special Student. For the past 27 years he served as adviser to managers of research and development in government and industry, and conducted a series of research projects on the evaluation of research and development activities and related innovation and information processes in the public and private sectors. He is now a senior associate, Institute of Public Administration, and also President, Management Counsel Inc.

The Exploration of Comets

A mission to these celestial objects would involve a flyby or a rendezvous. The spacecraft that does it will require a remarkable means of propulsion.

M. Neugebauer and R. L. Newburn, Jr.
Jet Propulsion Laboratory

People living in the second half of the 20th century are far less conscious than their forebears of one of the most beautiful and mysterious classes of objects in the solar system, for ubiquitous electric lights and widespread atmospheric pollution have reduced even the brightest of comets to poor objects indeed for city dwellers. Yet the lucky few who were in a clear, dark site in the early morning hours of March, 1976, saw one of the sky's most spectacular sights. They saw a great comet (named Comet West, after its discoverer), with two tails stretching up from the horizon 25 degrees or more from a bright cometary head to a final blending into the Milky Way. Most observers probably wondered exactly what they were seeing. So did many researchers. Recent efforts have gone a long way toward solving the mysteries of comets, but many questions still remain unanswered.

Part of the Solar Nebula?

Qualitatively, the key to the physical behavior of comets seems to be the "icy-conglomerate model," first published by F. Whipple in 1950 and since elaborated on by him and a number of other workers. According to this model, a comet is a sort of snowball comprising frozen gases and small non-volatile solids, the whole thing ranging from a few hundred meters in diameter for the smallest to a few tens of kilometers for the very greatest.

As this snowball approaches the sun, its volatiles begin to sublime. Ultimately they form a vast cometary atmosphere of very low density called the coma. Meanwhile, the small solids in the comet, both non-volatiles (dust) and frozen volatiles (icy grains), are lifted off the comet's surface by the aerodynamic drag of the escaping gases. Since the escape velocity is only a few meters per second from even the largest cometary surfaces, both solids and gases escape permanently. The dust moves antisunward and forms a tail because the repulsive force on it due to sunlight is somewhat greater than the force due to solar gravity. (Light, whether considered as an electromagnetic wave or as a particle — a photon — carries both energy and momentum, and thus exerts pressure when it falls upon any surface.) The gases that become ionized are subjected to much larger accelerations than the dust because of poorly understood interactions with the solar wind — the particles and associated magnetic fields that stream away from the sun. These gases form a separate ion tail. To be sure, not all comets have two visible tails, but if both are visible, the two types can be distinguished even without scientific study because the ion tail tends to be much longer and thinner and much more highly structured than the broad, fairly featureless dust tail. The ion tail is usually bluish, whereas the dust tail is yellow, although both appear colorless to the rather insensitive color receptors of the human eye.

A typical comet may lose 10^{12} to 10^{15} grams from a total mass of 10^{15} to 10^{18} grams during each of its trips through the inner solar system. It follows that after about a thousand trips around the sun, a comet is dead, its volatiles used up. Whether any sort of non-volatile core remains is unknown. Since the period of revolution of short-period comets is only about ten years (between 3.3

years and 13 years for most), the lifetime of a typical short-period comet is also quite short, about 10^4 years, compared to the age of the solar system (5×10^9 years). It is generally accepted that short-period comets result from the perturbing effects of Jupiter (and occasionally other planets) upon the orbits of long-period comets that pass near it, and especially upon those cometary orbits whose perihelia, or closest approach to the sun, lie near the perturbing planet. Even a comet with a period of 10^5 or 10^6 years would be pretty well used up in 5×10^9 years if its perihelion lay anywhere near the sun (unless, of course, it had been captured by the solar system relatively recently).

Where do comets come from? The capture of comets from interstellar space seems unlikely, for capture by the sun alone is impossible without a mechanism such as dust or gas drag to dissipate enough energy to retain the comet in the sun's gravitational field, and such a dust or gas is unknown. It is very unlikely, moveover, that capture by the combined gravitational field of the sun and a planet could occur sufficiently often to supply the solar system's population of about 100 short-period comets. Further still, there has *never* been a comet observed which approached the sun on a very hyperbolic orbit with velocity far above the velocity required to escape from the solar system, as might be expected on occasion if comets originated in interstellar space.

If comets originated within the solar system, when, where, and how did it happen? It is generally assumed that comets originated as a part of the solar nebula (the gaseous cloud from which the solar system is thought to have condensed), either among the outer giant planets or even beyond Pluto, in postulated satellite disks of the main nebula which had density sufficiently high for comets to form in a short time (10^3 to 10^4 years). A short time-scale is necessary because new stars at age 10^5 to 10^6 years emit an intense solar wind (the so-called T Tauri phase) which rapidly removes free-floating gas and small dust or grains, leaving nothing from which to form the comets. There is thought to be a vast number of comets (perhaps 100 billion) in cold storage 1,000 times as far from the sun as Pluto. The long-period comets we observe are supplied from this vast reservoir. Perhaps they are perturbed inward by an occasional passing star. If this is true, comets first formed as small accumulations of grains out of material left over from planetary formation in the outer solar system. The interiors of comets may therefore contain the most primitive matter, unchanged by heat or pressure or by melting, rearrangement and resolidification, that scientists are ever likely to study at close range.

It would be unfair to suggest, however, that the opinions of the previous paragraph are unanimous. Some respected scientists hold to an interstellar origin for comets. Others have suggested mechanisms for continuous creation within the solar system up to the present time. The various dissenting views have not yet been sorted out, largely because scientists know so little about comets even as they exist today. Consider that no cometary nucleus has even been observed as more than a mere point of light. Accordingly, even the size of any given comet must be guessed at by measuring its brightness and *assuming* a reflectivity. Similarly, mass is derived from size by *assuming* a density. Such properties as shape, rotation, morphology, surface and internal structure remain largely unknown.

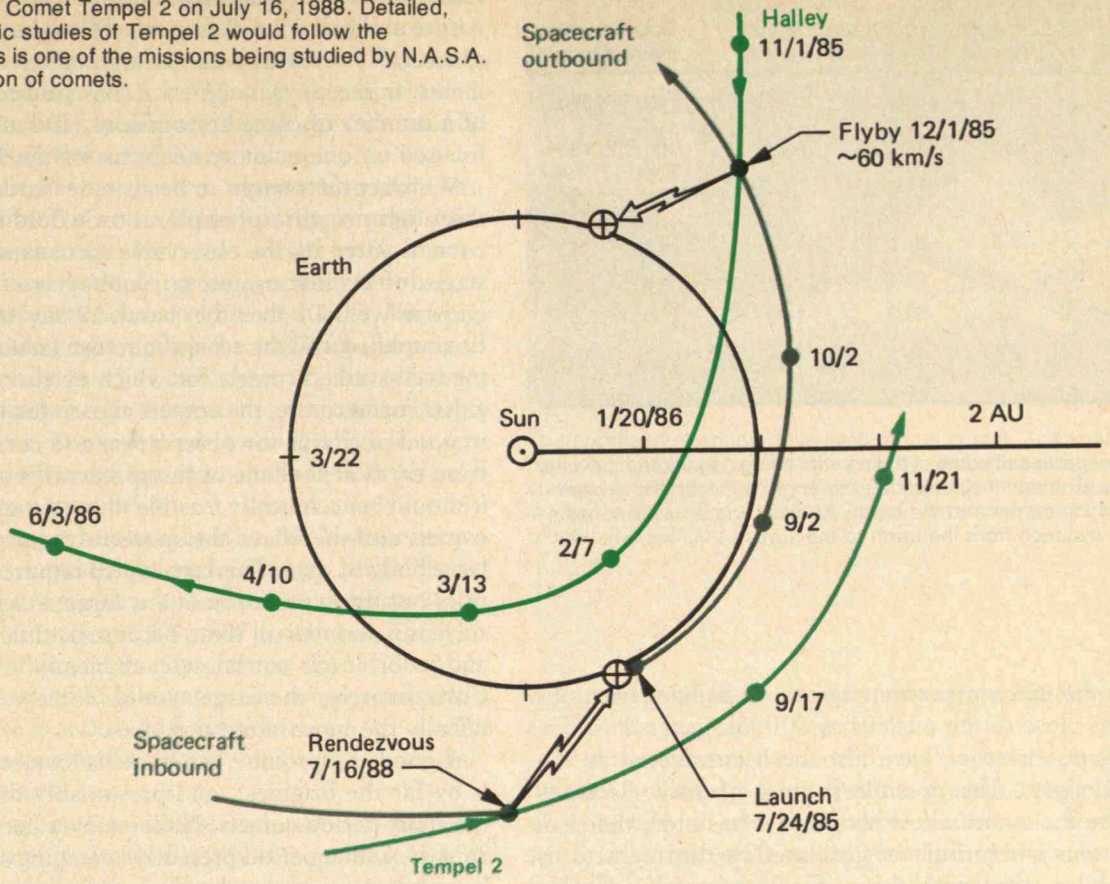
Clathrates in Comets

Comets generally exhibit an understandable spectrum, comprising sunlight scattered from the cometary nucleus and the solids in the coma, along with a number of discrete spectral lines which result in most cases from absorption and re-emission of certain frequencies of sunlight by the various gaseous species in the coma. Similarly, dust tails are seen spectroscopically by the slightly reddened sunlight that they scatter, and ion tails by their spectral lines. The spectra of comets indicate definite variations in the dust-to-gas ratio from comet to comet, and also variations in the relative gas abundances. On the other hand, the total volatile output appears to be more or less a function of the size of the comet, since it depends upon solar flux falling on the nucleus. One reason for Comet West's brilliant display is that it broke into four pieces near perihelion, thereby exposing more surface area to the sun.

Despite known variations in their abundances of different gases, most comets behave as if they were composed of water, for as they approach the sun, most short-period comets first become active near 3 A.U. (an A.U., or astronomical unit, is the distance from the earth to the sun), where the cometary surface first becomes warm enough to allow the sublimation of water-ice. One solution to this apparent paradox is that water-ice may trap small quantities of other volatiles in the ice lattice. The sublimation rate of the resulting aggregates, called clathrates, would be very close to that of water-ice. In 1970, the first satellite observations of bright comets at ultraviolet wavelengths provided support for the clathrate theory, since the observations showed vast coronas of atomic hydrogen with an abundance several hundred times greater than that of any previously observed cometary species. The hydrogen was presumably generated by the dissociation of water. The first direct observation of cometary water was the detection of H_2O^+ ions in Comet Kohoutek. In 1974, radio astronomers observed molecules of water in Comet Bradfield.

Nevertheless, the facile explanations involving clathrates appear inadequate for some comets, and many aspects of all comets remain unexplained. Comet Humason, for one, showed considerable activity 6 A.U. from the sun, and its spectrum was dominated by CO^+ rather than by the more typical CN and C_2. This comet could not have been water-controlled. Moreover, both Comet West and Comet Bennett probably contained more CO or CO_2 than could be locked up as a clathrate. Then, too, a number of comets have faded as r^{-n} (where r is distance from the sun and n is between 3 and 6), far beyond 3 A.U. A bare, inactive nucleus with no coma would have to fade following an inverse square law: n would equal 2. Finally, infrared observations show that dust output varies both in quality and quantity from comet to comet. A spectral feature in the infrared due to silicates has been observed

The trajectory of an ion-drive spacecraft which flies close to Halley's Comet on December 1, 1985, and then continues to a rendezvous with Comet Tempel 2 on July 16, 1988. Detailed, close-up scientific studies of Tempel 2 would follow the rendezvous. This is one of the missions being studied by N.A.S.A. for the exploration of comets.



in the comas and tails of Kohoutek and other comets, but were absent from Comet Kobayashi-Berger-Milon.

All of these observations lead to one central question: What is the composition of cometary nuclei? Ground-based optical astronomers have observed only free radicals, atoms, and ions in comets, most prominently such species as CN, C_2, and C_3 in the coma and CO^+ and N_2^+ in the ion tail. Radio astronomers have added three stable molecules, H_2O, HCN, and CH_3CN. Ultraviolet observations of Comet West from above the atmosphere recently added CO and probably CS. But there are many radicals and ions observed for which the parents are simply unknown. Some observed species may be products of the light-induced dissociation of stable components of the cometary nucleus, while others are very likely produced by various chemical reactions, especially ion-molecule interactions, in the inner few thousand kilometers of the coma, where densities are sufficiently high for collisions to occur.

A few comets have exhibited spectacular departures from typical, predictable behavior. In May, 1973, Comet Tuttle-Giacobini-Kresak suddenly flared up in brightness by about 9 magnitudes (a factor of 4,000) in less than five days; the comet was near its perihelion of 1.15 A.U. Lesser outbursts followed for several weeks. Another comet, Schwassmann-Wachmann 1, takes a nearly circular orbit just beyond the orbit of Jupiter and shows outbursts of 4 to 7 magnitudes (a factor of 40 to 600) at an irregular rate averaging at least several times a year. Even Comet Halley ejects variable jets and envelopes of material from its nucleus and shows occasional secondary nuclei. Many comets behave asymmetrically relative to perihelion, Comet Encke being brighter before perihelion and Comet d'Arrest afterward. The unpredictable, sporadic behavior of comets has been attributed to everything from pockets of volatile material or meteoric impacts to recombination of free radicals or sudden phase changes.

Another area of speculation and theoretical effort centers on the attempt to discover how the atmospheric gases surrounding a comet become ionized after they have sublimed and left the cometary nucleus. To be sure, sunlight no doubt ionizes a portion of the atoms and molecules in question, but the average lifetime against photoionization is approximately ten days, during which time the gas would travel approximately a million kilometers, or well beyond the coma. The solar wind also is capable of ionizing cometary material. Here the ionization occurs through charge-exchange reactions of the type $H^+ + X \rightarrow H + X^+$, where H^+ denotes a solar wind proton and X is a cometary molecule. Under typical solar wind conditions at 1 A.U., however, the process is only a factor of three faster than photoionization. It is possible that close to the comet the lifetime against charge-exchange reactions might be shortened if the solar wind were concentrated by passing through a bow shock — a shock wave which may precede the comet as it plows through the interplanetary gas. Alternatively, the wind might pile up against a cometary magnetic field. However, in most theories, the solar wind is deflected around the comet and does not pene-

Comet	Period (years)	Inclination (degrees)	Closest approach to sun (A.U.)	Date on which closest to sun
Halley	76	162.2	0.59	Feb. 9, 1986
Encke	3.3	11.9	0.34	Mar. 27, 1984 Sept. 17, 1987 Nov. 3, 1990
Giacobini-Zinner	6.5	31.9	1.03	Sept. 6, 1985
Borrelly	6.8	30.3	1.36	Dec. 18, 1987
Tempel 2	5.3	12.4	1.38	Sept. 16, 1988

Orbital properties of some of the comets being considered for visits by space probes. "Inclination" is the angle between the orbital planes of the comet and the earth. An "A.U." is an astronomical unit: the distance from the earth to the sun.

trate to the inner ionization regions. (Ions have been observed as close to the nucleus as 500 kilometers.)

Energetic electrons have also been considered as the ionizing agent. The possible sources of such electrons would be the comet's bow shock (if it has one), the electric currents and turbulence generated by the interactions of the solar wind with the cometary plasma, and also Alfvén's mechanism, in which ionization occurs rapidly when a neutral gas flows through an ionized gas at a critical velocity associated with the ionization energy of the material. However, energetic electrons would be more likely to dissociate molecules than to ionize them, and the dissociation rates calculated from observations of cometary comas can be accounted for by photodissociation alone.

It now seems most likely, but by no means certain, that the ionization is produced by a cascade process in which a few ions created by sunlight and chemical reactions are accelerated and then collide with and ionize other molecules. What then are the mechanisms responsible for the acceleration? The required momentum and energy almost certainly come from the solar wind, and the presence of filamentary structures suggests that magnetic fields play an important role as well. These latter would confine and perhaps accelerate the ionized cometary gas. The source of a cometary magnetic field isn't known, however; the field could be generated by fluid motions in the coma or it could originate in the solar wind. The physical process involved in transferring momentum from the solar wind to cometary ions also remains a subject for speculation; viscous drag could be important, as could a merging of interplanetary and cometary magnetic fields, or one of several instabilities in a mass of ionized gas. Finally, since even a very tenuous ionized and magnetized gas behaves like a fluid, aerodynamic-type forces may be important; perhaps comets themselves can generate an analog to the solar wind.

Mission to a Comet

Many of the speculations and questions concerning the nature and behavior of comets will not be resolved until a spacecraft is sent to a comet and makes direct measurements. In recent years N.A.S.A. has studied the feasibility of a number of cometary missions, and attention is now focused on one or more missions for the 1980s.

Which comets ought to be visited? Naturally enough, a thorough program of exploration would include several comets. After all, the observable specimens are in various stages of evolution, and no doubt have intrinsic differences as well. On the other hand, mission planning would be simplified and the scientific return enhanced by choosing well-studied comets for which extensive data already exist. Furthermore, the comets chosen for visits should be in good positions for observation and correlative studies from earth at the time of the spacecraft's arrival. Finally, it should be technically feasible to get the spacecraft to the comets and then have the spacecraft return a reasonably large body of data. This last-named requirement probably rules out the exploration of any large, long-period comet, such as Kohoutek or West, because its time of appearance and its orbit are not known sufficiently long in advance. Unfortunately, the large, young comets may be scientifically the most interesting ones.

A good compromise candidate is Comet Halley, which is by far the brightest, and presumably the youngest, of the short-period comets. Halley moves between 0.59 and 35 A.U. with a period presently averaging about 76 years. Its regular appearance has been traced in ancient records as far back as 86 B.C. Its nucleus is estimated to be about five kilometers across. From this tiny center emerges a visible coma with a diameter of 300,000 kilometers and an ion tail which is sometimes more than 100,000,000 kilometers, or three-quarters of an A.U., long. The hydrogen coma of Halley's comet, which has yet to be observed, may be 10 million kilometers in diameter.

Other comets are being considered for early visits. All are much less bright and all have smaller, shorter-period orbits than Halley. The four principal candidates are Encke, Giacobini-Zinner, Borrelly, and Tempel 2.

Of these four comets, only Encke is bright enough to have been seen without a telescope. Encke has the shortest period — only 3.3 years — of any known comet. It was discovered in 1786 and has been seen on almost every return since then. Each time it approaches the sun, it passes inside the earth's orbit to its perihelion at 0.34 A.U. The diameter of its observable coma is about 10^5 kilometers, while its thin ion tail is typically a million kilometers long. Encke does not develop an observable dust tail, which means it does not eject very many dust grains of the approximately 1 micron (10^{-6} meter) size which scatters light efficiently. The fact that there is a meteor stream, the Taurids, associated with Comet Encke is evidence that it may emit somewhat larger grains. The Taurid meteors do not break up on entering the earth's atmosphere as readily as many meteors do, which indicates that they have a fairly rigid structure.

Giacobini-Zinner, on the other hand, is very dusty in comparison with other short-period comets, although its

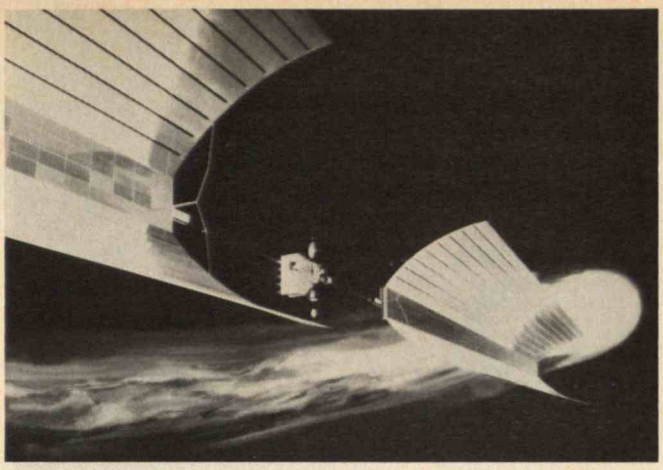
dust output is only about a thousandth that of Halley. The Giacobinid (or Draconid) meteor showers are thought to be caused by dusty debris from this comet; they have been among the most spectacular meteor showers seen this century. The meteors in the Giacobinid showers are unusually fragile and break up very readily when encountering the earth's atmosphere.

Comet Borrelly has not been as extensively studied as Comets Giacobini-Zinner or Encke, partly because two large perturbations to its orbit were caused by close passages by Jupiter and resulted in poor geometry for observing Borrelly from earth between 1936 and 1972. Viewing should be good, however, during the 1987 appearance of this comet. Borrelly never comes closer to the sun than 1.36 A.U. It is fairly active for a comet with such a large perihelion distance. Its bright, narrow tail, which is about half a million kilometers long, can usually be seen for several months around perihelion.

Comet Tempel 2 was discovered in 1873, when it appeared to have several bright nuclei. Only a single bright nuclear region has been detected on the 15 sightings since then. Its production rate is 60 times lower than Encke's, in part because this comet stays farther than 1.38 A.U. from the sun. At 50,000 kilometers, its coma is only half as wide as Encke's, and its 150,000-kilometer tail is only one-seventh the length of Encke's. Tempel 2 is a moderately dusty comet.

The simplest type of cometary exploration is called a "flyby": a spacecraft simply flies by the comet, perhaps passing through the tail or the coma, and takes pictures of the nucleus as it speeds by. The amount of time available to obtain useful data depends both on the size of the comet and on the velocity of the spacecraft relative to the comet. Unfortunately, Halley is in a retrograde orbit, which means that it circles the sun in a direction opposite to the directions of the earth and the rest of the planets. Because the spacecraft and Halley would thus be going around the sun in opposite directions, the relative velocity at encounter would be very high — about 57 kilometers per second — and the cometary encounter would last only a few hours. Encounters with the other comets under consideration would be similarly short because, although the encounter velocities would be much lower (in the range of 13 to 25 kilometers per second), the dimensions of the comets are significantly smaller than Halley's.

It also is possible to fly past two comets with a single spacecraft. For example, it is possible to launch a spacecraft from the Space Shuttle in August, 1985, fly past Halley at 58 kilometers per second in March, 1986, then pass close to the earth one or more times to change the spacecraft's trajectory by gravity assist, and finally fly by either Comet Borrelly at 18 kilometers per second in January, 1988, or Tempel 2 at 13 kilometers per second in September, 1988. Another possible combination is to fly first past Comet Giacobini-Zinner in September, 1985, with an encounter speed of 21 kilometers per second and then, after two gravity assists from the earth, proceed to fly past Comet Borrelly in December, 1987, with an encounter speed of 17 kilometers per second. A two-comet mission is attractive because it allows the study of two comets with compositions and behaviors quite different from each other.



The approach of an ion-drive system to a comet. The vehicle is powered by sunlight which falls directly onto solar cells and by sunlight reflected onto the cells by adjustable mirrors. The power is used to ionize and accelerate mercury in an exhaust beam that propels the spacecraft.

A more ambitious type of mission is a cometary "rendezvous," which requires that the spacecraft be placed in the comet's path with a negligible relative velocity; that is to say, the spacecraft would travel along with the comet for weeks or months. The advantages of a rendezvous over a flyby are considerable. Because of the much longer time to navigate and maneuver, a rendezvous spacecraft can come much closer to the cometary nucleus. Thus much finer detail can be seen. With a rendezvous, moreover, the comet can be studied in both its active and inactive conditions as the distance from the sun changes. The spacecraft can keep a safe distance while the comet is spewing dust and then slowly approach as activity dies down. The nucleus can be circumnavigated and observed from all sides. Many of the scientific instruments which might be carried on a rendezvous mission are not sufficiently sensitive to be used on a flyby. In addition, analysis of the gases in the comet's atmosphere or coma is impaired when the relative velocity between spacecraft and comet is great enough (above about five kilometers per second) to break up the molecules on impact.

A rendezvous with a comet is a technological challenge. The approach being studied by N.A.S.A. involves an ion-drive vehicle which would be launched from the Space Shuttle and would continuously propel the spacecraft for a period of a year or more, depending on which comet is the target. The ion rocket is propelled by electrical energy, converted into the kinetic energy of the rocket's exhaust beam. The propulsion system consists of two essential components: solar-cell arrays which convert sunlight into electricity, and ion engines, in which a mercury-vapor propellant is ionized by electron bombardment. The mercury ions are focused by electric and magnetic fields and then delivered to a pair of grids that accelerate them through an electrostatic potential of over

Top:
Comet West, as it appeared just before sunrise on March 4, 1976. When closest to the sun, this comet was about as bright as Jupiter. Its nucleus then split into four pieces and the comet became one of the more spectacular of the century. This photo was taken by A. L. Lane of the Jet Propulsion Laboratory staff with a 35-mm camera from Mount Wilson, California.

Bottom:
Comet West as it appeared on April 1, 1976. The photograph was taken by the Joint Observatory for Cometary Research, operated by Goddard Space Flight Center and the New Mexico Institute of Mining and Technology.

1,000 volts. The ions are thus expelled from the rocket at very high exhaust velocities. Separate beams of electrons are also ejected to keep the vehicle from building up a large electric charge.

The advanced ion-drive system required for a rendezvous with a comet has not yet been built or tested. Still, the technology has more than a decade of N.A.S.A. developmental work behind it. In fact, ion engines launched in 1970 and 1971 on S.E.R.T. (Space Electric Rocket Test) are still being operated regularly in earth orbit.

Because at least four years are required to ready an ion-drive system and spacecraft, it is already too late to rendezvous with Halley's Comet, which requires a launch in 1982. A flyby of Halley is still possible, however. One mission receiving serious consideration involves launching an ion-drive spacecraft in July, 1985, which flies by Halley 130 days later and then proceeds to a rendezvous with Tempel 2 in July, 1988. It also is possible to launch in 1985 to rendezvous with Comet Encke in 1987.

What Can Be Learned

Before either a rendezvous or a flyby mission of any sort is approved, it must first be determined just what can be learned from a cometary visit that cannot be learned from the use of good telescopes on earth. Most important, perhaps, would be the first resolution of a cometary nucleus, for with television cameras, which have already been proven for use in space, it would be possible to determine the nature of the nucleus together with its size, shape, morphology, rotation rate, and optical properties, including color. Then there is the magnetic field of a comet, which could be measured, if it exists, by one of several present-day types of magnetometer. Third is the surface temperature of a cometary nucleus, which could be mapped by an infrared radiometer. At the same time, an infrared spectrometer would allow the detection of ices and silicates on the surface of the nucleus and in the grains surrounding it. These infrared measurements are probably not feasible, however, in the short time spent close to the nucleus during a flyby mission. A rendezvous would be necessary. Two other instruments for which a rendezvous is required are x-ray and γ-ray spectrometers. Both of these instruments have been used for mapping lunar composition from low-altitude satellites circling the moon. Here, of course, they would analyze the composition of the cometary nucleus. The x-ray spectrometer detects x-rays excited in the surface material by solar x-rays: the different elements in the nucleus would emit x-rays of different wavelengths. The γ-ray spectrometer detects γ-rays caused by natural radioactivity (especially of uranium, thorium, or potassium) or by the bombardment of a cometary nucleus by cosmic rays. Again, the energy or wavelength spectrum would be characteristic of the surface material.

Cometary astronomers would like to know both the mass and density of the cometary nucleus, but these parameters may be very difficult to determine; for it probably is not possible to use the usual method of observing the perturbations of a spacecraft trajectory by the gravitational field of a target body (here, the comet) be-

cause of the poorly known (but almost certainly large) drag on the spacecraft by the gases and dust streaming from the cometary nucleus. It is not even known whether the net force (gravity minus drag) between the spacecraft and the nucleus will be attractive or repulsive when the comet is anywhere near the sun, and hence fairly active. Studies are currently underway to determine the feasibility of adjusting the trajectory of the spacecraft so that it follows that of a "test mass" which floats freely within the spacecraft and is shielded from all drag and other nongravitational forces.

Also under study is the possible use of an instrumented probe that would land on the comet's surface to obtain data on conditions on and below the surface.

More modest instruments — namely lightweight mass spectrometers and thermal plasma analyzers — could be used to analyze the gases and ions in a comet's coma and ion tail respectively. After all, such instruments have already been flown on many earth satellites. However, there is a problem in that the relative velocity between the ions and the walls of the mass spectrometer during the fast flyby of a comet would be sufficient to break up cometary molecules upon impact before they could be analyzed. High-resolution spectrometers for the determination of both the mass and the velocity of ions which may be moving as rapidly as several hundred kilometers per second are being developed in several laboratories.

Perhaps the most difficult thing to analyze is the cometary dust. To be sure, the energy associated with the impact velocity of the dust on a detector could be used to vaporize and ionize the dust particles during the course of a flyby mission. The resulting ions could be analyzed by a mass spectrometer. However, existing instruments of this type do not yet have very good mass resolution. In a rendezvous, on the other hand, the spacecraft velocity is negligible and the velocity of the dust relative to the spacecraft is half a kilometer or less per second. The particles thus are not vaporized, but may break up upon impact.

Several instruments are under consideration for analyzing captured cometary dust, once it is somehow caught. In one such instrument, the dust would be bombarded by alpha particles from a radioactive source, and the energy spectrum of the scattered alphas would be measured to yield a quantitative measure of the various elements present. X-ray diffraction measurements might also be useful to determine crystal structure. The most ambitious instrument under study is a scanning electron microscope which would not only yield highly-magnified pictures of individual dust particles but would also give valuable information about composition. When the highly-focused electron beam hits the dust particle, x-rays are emitted with an energy spectrum characteristic of the atoms at the site; the scanning electron microscope would have a mode of operation in which an x-ray spectrometer yields a chemical analysis for each spot of the microscope's picture.

What about the next generation of cometary explorations? Even a rendezvous is not the ultimate mission, for an advanced ionic propulsion system could be used to land a spacecraft on a comet and return a sample of its nucleus to earth. Several sample-return missions to Comet Encke or other short-period comets are therefore possible in the late 1980s and 1990s. Such missions would take five or six years and would return up to 100 kilograms of material to earth, either for analysis in orbit on a Spacelab-type facility or for ultimate return to earth-based laboratories. Only after a few successful sample-return missions will cometary astronomers feel they have a thorough understanding of these most exotic members of the solar system.

Suggested Reading

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Authors Note: We thank Dr. Kenneth L. Atkins for his contribution concerning ion-drive propulsion.

The U.S. effort to reduce automotive air pollution is less effective than it should be — and more expensive than it need be. Effluent fees levied against vehicles on the basis of their pollution potential would be simple and direct, a welcome contrast to today's bureaucratic muddle.

Auto Emissions: Why Regulation Hasn't Worked

Edwin S. Mills
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Lawrence J. White
New York University

The government program to control motor vehicle emissions in the United States is a well-intentioned effort to limit an important source of atmospheric pollutants. But the program has been poorly designed, with the result that progress in controlling emissions has been slow, costs have been high, and incentives for motorists and manufacturers to seek and apply methods of reducing emissions have been badly distorted.

An alternative approach, relying mainly on effluent fees, would have yielded faster, less costly progress in emissions control. It would also have assured continuing incentives for research and development on new and improved control devices and sources of motive power. Our suggested program, even if implemented today, could still yield substantial improvements for the 1980s.

A Problem of Unusual Dimensions

Several features distinguish the problem of motor vehicle emissions from other pollution control problems:

☐ The sources of motor vehicle emissions are numerous, and ownership is dispersed. More than 130 million cars, trucks, buses, and motorcycles move on American roads, with about 100 million separate owners. In contrast, serious air pollution is created at only a few thousand stationary sources, owned by only a few hundred thermal electric companies and manufacturing firms. These differences in numbers dramatically affect the nature and cost of control programs and the political issues that surround them.

☐ Motor vehicle emissions are ubiquitous, concentrated where people live and work. Unlike thermal electric plants, for example, the emissions sources cannot be relocated away from population centers.

☐ Emission controls that require extra weight or bulk result in serious fuel and space penalties; for the vehicle owner, these translate directly into economic penalties.

☐ The vehicles are mostly small power sources, owned and operated by amateur drivers. They typically receive only sporadic and unreliable technical care. Thus differences between the performance of emissions control devices under laboratory conditions and in practice are likely to be large.

Frustrations, Delays, and Disincentives

Concern about motor vehicles' contribution to air pollution first arose in southern California in the early 1950s, following the demonstration in 1951 by Professor A. J. Haagen-Smit of the California Institute of Technology that motor vehicle emissions were key contributors — along with industrial emissions, backyard trash incinerators, and specific atmospheric conditions — to photochemical smog. Southern California government officials soon began suggesting to the automobile manufacturers that they do something about emissions, but the manufacturers first responded by denying the major role of emissions as a source of smog. Then the auto makers formed a joint committee through the Automobile Manufacturers Association to study the problem. In mid-1955 they signed a cross-licensing agreement granting all manufacturers access on a royalty-free basis to any emission-control patents owned by member firms.

This collaboration may have been beneficial by facilitating the exchange of new knowledge about emissions control among the companies. But it surely had an overall delaying effect by reducing each company's incentive to pursue research so as to gain a competitive advantage. Since control devices could only add to cost without making the product more useful to a buyer, the interest of the industry as a whole lay in delaying research, discouraging the release of information to outsiders (particularly to government officials), and painting emission control as impractical and extremely costly — all to delay the day when it would be required. Without the cross-licensing agreement, each company would have had a competitive incentive to pursue research intensively so as to gain public recognition and licensing royalties when controls were required.

Concern for emissions soon spread nationwide, and in the latter part of the 1950s a predictable pattern emerged: government officials called on the automobile industry to do something about emissions, and the industry re-

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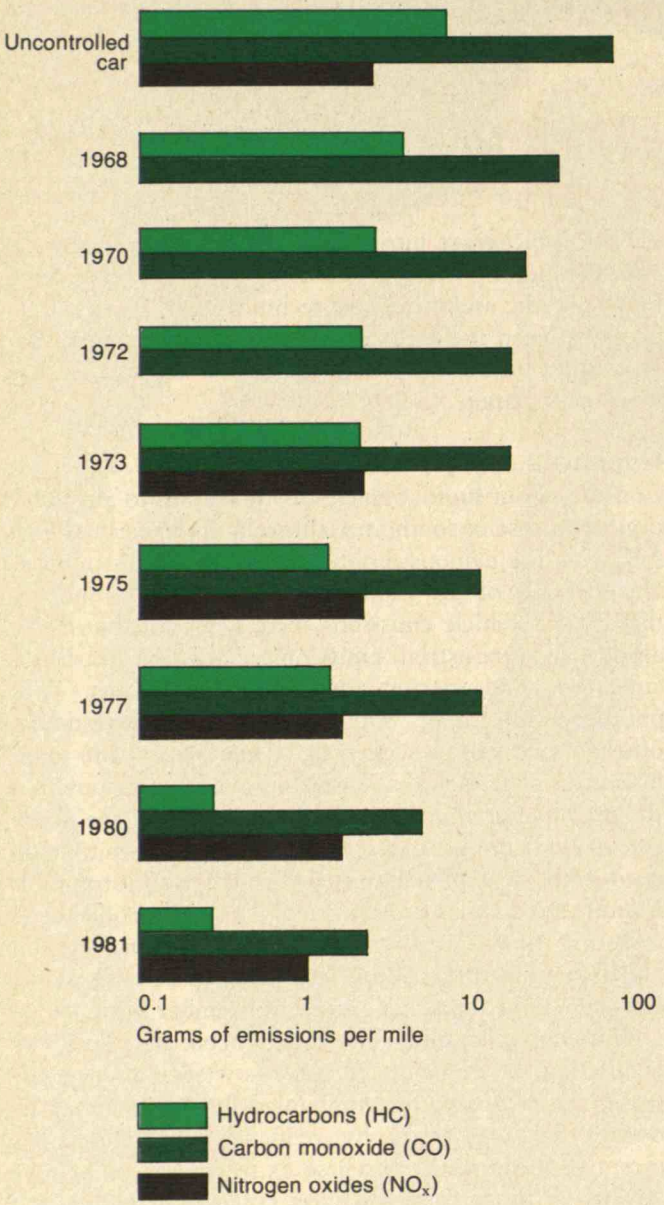
Photos: Roger Goldstein



Increasingly stringent standards were set beginning in 1968 by the Executive Branch and later by the Congress, whose Amendments to the Clean Air Act in 1970 sought to force innovation by setting standards which were beyond the capabilities of existing technology. When automakers reported they would be unable to meet original standards of 1975 and 1976, the Environmental Protection Agency (E.P.A.) and Congress reneged on the implied threat to ban manufacturing of new cars; goals originally due to be achieved by 1975 and 1976 have now been set back to 1980 and 1981, the original standards may never be enforced.

sponded with, "Complex problem. Needs more research." Government funds for research on the problem were not forthcoming, and government provided little incentive for the industry to quicken its pace.

Finally, in 1959, "blow-by" emissions were "discovered" to account for roughly 20 to 25 per cent of the hydrocarbon emissions of a conventional car. (Blow-by is the collection of unburned and partially burned hydrocarbons that slip past the piston rings from the combustion chamber into the crankcase. Allowed to collect there, the vapors would contaminate and thin the crankcase oil; accordingly, a blow-by port was provided to vent these fumes to the atmosphere.) Since the blow-by port was specifically designed to allow fumes to vent to the atmosphere, and since the technology to control these emissions had been known since the 1930s and had been installed on some commercial and industrial vehicles in the 1940s, it is curious that the "discovery" took so long. In any event, in 1961 the manufacturers "voluntarily" installed positive crankcase ventilation devices to eliminate blow-by emissions on all new cars sold in California, and in 1963 the devices were installed on new cars nationwide.

By 1963, the California legislature, weary of relying on the industry's professed good will but slow progress, finally provided some direct incentives for faster technological development. Legislation required that exhaust emissions control systems be installed on all new cars sold in California no later than one year after the state had certified that systems were practical and available at reasonable cost. This opened the field to independent manufacturers.

In March, 1964, the auto companies told the state the 1967 model year was the earliest that they would be able to install exhaust control devices. But in June, 1964, the state certified four devices offered by independent parts manufacturers who were not influenced by the automobile industry's joint interest. As a result, exhaust control devices became mandatory for the 1966 model year. In August, 1964, the auto companies announced that they would, after all, be able to provide exhaust control devices — of their own manufacture — for the 1966 model year.

When the companies finally admitted to California that exhaust control devices were feasible, further delays at the national level were not credible. At congressional hearings in that year industry spokespeople announced that, though they still doubted the wisdom of mass installation of emissions control devices, they were prepared to install exhaust control devices if required. Thus the 1965 amendments to the Clean Air Act directing the Secretary of Health, Education, and Welfare (H.E.W.) to set emis-

sions standards for automobiles, and standards for hydrocarbons (HC) and carbon monoxide (CO) became effective on January 1, 1968. The Secretary of H.E.W. (and, later, the Administrator of the Environmental Protection Agency) subsequently set tighter standards for HC and CO for later years, set separate controls on evaporative emissions (from gas tanks and carburetors), and for 1973 added nitrogen oxide (NO_x) to the list of controlled pollutants (the devices which reduced HC and CO emissions tended to increase nitrogen oxide emissions).

By 1970 the environmental movement was at its zenith, the automobile was being held directly or indirectly responsible for much of the alleged deterioration of the environment, and there was dissatisfaction in Congress with the progress on emissions control. A report by Delbert Barth and his colleagues at the National Air Pollution Control Administration (a predecessor agency to the Environmental Protection Agency) provided a critical impetus in that year. The report postulated threshold levels of pollutant concentrations above which there might be significant health risks to exposed populations, and it identified the locations of the worst pollutant concentrations. On the basis of an assumed doubling of the automobile population by 1990, they predicted that these worst pollution concentrations would more than double by 1990. And they applied a roll-back model — an assumed simple proportional relationship between emissions and pollutant concentrations in the atmosphere — to determine how much automotive emissions would have to be reduced to assure pollutant concentrations below the threshold levels. These results, somewhat modified, became the basis for the standards mandated in the 1970 amendments to the Clean Air Act: a 90-per-cent reduction in HC and CO emissions (from 1970 levels) by 1975 and a 90-per-cent reduction in NO_x emissions (from 1971 levels) by 1976. Congress had earlier simply authorized the administrative bureaucracy to set standards; now Congress itself was setting standards — and in the process showing contempt and vindictiveness for both the automakers and the federal agencies. The legislation was specifically intended to force the companies to speed their emissions research; the 90-per-cent reductions were then beyond the technical capabilities of the automobile industry. Congress, apparently confident that American technology could work miracles, was satisfied with its "or else" sanction — its implied threat to shut down production in the event of non-compliance. It fully expected the companies to comply by 1975 and 1976; but it recognized that technology was somewhat uncertain, and so the Environmental Protection Agency (E.P.A.) was given the power to grant a single one-year delay in enforcing the standards if it found that technology was unavailable after the companies had made a good-faith effort to discover it; and Congress retained the option of amending the legislation to delay or soften the standards. These options crippled the "or else" sanction: all parties knew that neither E.P.A. nor Congress would shut down the entire automotive operations of General Motors, Ford, or Chrysler for a significant time. (The Act permitted the E.P.A. Administrator to grant a one-year delay in the enforcement of the 1975 and 1976 emission standards, but only on the grounds of technological infeasibility.)

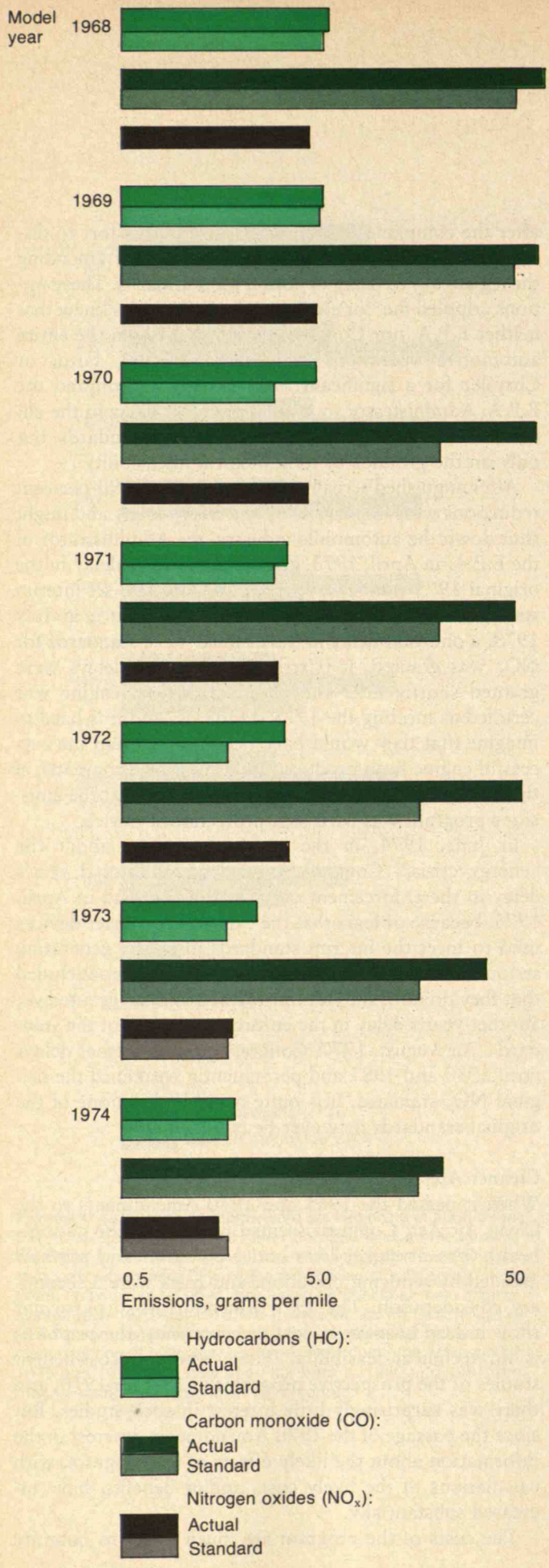
After anguished screams that the mandated 90-per-cent reductions were impossible or extremely costly and might shut down the automobile industry, the Administrator of the E.P.A. in April, 1973, granted a one-year delay in the original 1975 standards for HC and CO and set interim standards for 1975 (*see the table on page 56*); in July 1973, a one-year delay in the original 1976 standards for NO_x was granted. It is striking that these delays were granted shortly after the Honda C.V.C.C. engine was certified as meeting the 1975 standards, and it is hard to imagine that they would have been granted had the successful engine been produced by a large U.S. company; if that postulate is correct, it is fair to charge that the emissions program was used as a protectionist device.

In June, 1974, in the wake of concern about the "energy crisis," Congress granted an additional year's delay in the enforcement of all standards. And in April, 1975, because of fears that the catalytic converter devices used to meet the interim standards might be generating serious sulfur oxide emissions (E.P.A. has since concluded that they do not), the Administrator of E.P.A. granted yet another year's delay in the enforcement of all of the standards. An August, 1977, Congress granted further delays until 1980 and 1981 and permanently weakened the original NO_x standard. It is quite possible that none of the original standards may ever be enforced.

Cleaner Air: What Benefits, at What Cost?

When it passed the 1965 and 1970 Amendments to the Clean Air Act, Congress seemed to act as if the nation's health was at stake; lives could be saved and sickness avoided by reducing pollution, and costs were a secondary consideration. The 1970 Amendments in particular show a deep hostility to cost measurement; the emphasis is on technical feasibility. There were no cost-benefit studies of the prospective programs in 1965 or 1970, and there was surprisingly little interest in such studies. But since the passage of the 1970 Amendments, interest in the information about the likely effects of the program, with calculations of the likely costs and/or benefits, have increased substantially.

The costs of the program are much easier to quantify



The performance of automotive emission controls compared with the standards with which they were intended to comply. The chart shows the average emissions, compared with federal standards, for cars tested in 1974 in five American cities — Detroit, Houston, Los Angeles, Newark, and St. Louis. Only 15 per cent of the 1973 models tested for all three pollutants in the five cities, and only 42 per cent of the

than are the benefits. In principle, cost estimates should include the cost of emissions control hardware, the cost of extra fuel necessitated by the controls, any extra maintenance costs (including the owner's time), an estimate in dollars of the decreased satisfaction of consumers if the controls diminished the performance of the car, and the costs of administering the program itself.

The cost estimates actually made (none include the administrative costs) have been surprisingly consistent over time, despite improvements in and increasing certainty of control technology. In 1972, the report of the U.S. ad hoc Committee on the Cumulative Regulatory Effect on the Cost of Automotive Transportation (R.E.C.A.T.) estimated costs of the original 1975 standards at $426 per car; the Committee's estimate of the cost of the original 1976 standards was $935 per car. In 1974, a National Academy of Sciences (N.A.S.) study found that the extra cost for an intermediate six-cylinder car meeting the original 1975 standards would be $400 (1974 dollars) with a $200 uncertainty; the original 1976 standards were estimated to cost $600 per car, with a $350 uncertainty band. Since these estimates include the charges for initial hardware and subsequent extra fuel and maintenance and since it takes time for the automobile stock to turn over, maximum annual costs — a total of $8 billion — would not be reached until 1985. The N.A.S. study assumed that costs would remain at that level thereafter, with technological improvements offsetting increases in the size of the national automobile fleet. The study estimated the discounted total costs for the period 1975 to 2010 to be $126 billion.

Unfortunately, these cost estimates are probably too low. They neglect the costs of consumer dissatisfaction with cars that have inferior performance characteristics, which could well be substantial for some models. They also neglect the cost of owners' time and inconvenience as a result of extra maintenance. Furthermore, the cost estimates are based on comparisons with 1970 cars, and the post-1970 savings from improvements in fuel economy (which are mostly a response to higher fuel prices after 1973), are incorrectly subtracted from the costs of the program. Accordingly, the N.A.S. estimates may be too low by a sixth to a third, depending on the year.

In any event, the costs of the emissions control program are substantial. And their incidence is likely to be regressive, since the standards increase the cost of automotive transportation which absorbs a larger fraction of the incomes of poor than of rich people.

The benefits of the emissions control program, which occur because of improvements in the ambient air, are much more difficult to quantify. Among them are: delayed deaths; illnesses avoided, delayed, or made less se-

relatively new 1974 models, could pass all three standards. The emissions of cars in service exceeded the standards to which those cars were supposedly built, and older cars exceeded their standards by ever-greater margins. Tests in a sixth city, Denver, showed even greater violations of standards, presumably associated with Denver's high-altitude conditions.

vere; reduced or avoided physical discomfort or annoyance from polluted air; decreased destruction of agricultural crops; and decreased materials deterioration. A study for the National Academies of Sciences and Engineering (1974) assigns a value of $200,000 to each death delayed but makes little effort to defend the figure. It also chooses a range of $1 to $20 for the value of a prevented person-day of discomfort or restricted activity. Problems of uncertainty and of double-counting and under-counting aside, the Academies' report provides a best guess of $5 billion per year in benefits (in 1973 dollars and at 1970 income and population levels), with a likely range of $2.5 billion to $7.5 billion. Again, since the automobile fleet will not turn over immediately, the full benefits will not be realized until 1985. Then, given higher incomes and larger urban populations, the best guess of benefits is $7.2 billion; for 2010, $13.6 billion. The discounted benefits for 1970 through 2010 come to $137 billion. This compares with the discounted costs of the program estimated by the Academies at $126 billion.

But we have argued above that these costs are underestimated by a sixth to a third. And the benefits are probably over-estimated, since the report assumes that cars actually on the road will meet the standards, whereas (as we will show later) emissions from actual use may exceed any specified standards by 20 per cent or more.

Further, the conclusion that total benefits of the program are roughly equal to total costs is a serious indictment. This equality of *total* costs and benefits implies that *marginal* benefits are very likely below *marginal* costs and that the program could be significantly improved by less stringent standards or, as we shall see below, an alternative approach to the nation's emissions problem. At best we must conclude on the basis of these estimates that the program as originally enacted may be worthwhile — but only marginally so. Unfortunately, these estimates rely on benefit assessments that assume that the program will operate as prescribed by the Congress. The fact is that the goals of the program are not being achieved in practice.

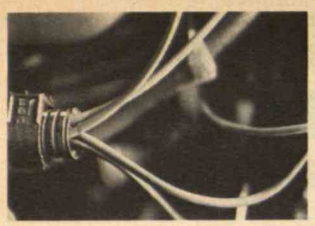
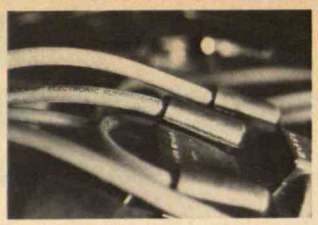
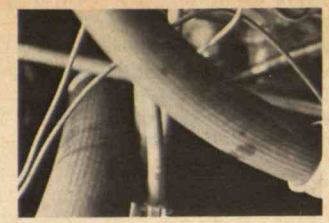
Loopholes and Disincentives: Evaluating the Act

By the standards of many Washington regulatory agencies, E.P.A.'s administration of the automotive emissions program appears quite good. E.P.A. has been even-handed in its decisions, and the agency has become a tool of neither the manufacturers nor the environmentalists. Though fairness does not imply an efficient outcome, this is no trivial accomplishment.

But for a number of reasons, automotive emissions in the U.S. are probably higher than the Congress specified in the Clean Air Act and its amendments:

- Until 1976, E.P.A.'s certification that an automobile met relevant emissions standards involved testing representative vehicles delivered by manufacturers to E.P.A.; assembly-line audits began only during the 1977 model year. Once the test vehicles have been certified, no further tests are required to see if vehicles in actual use conform to the standards.
- The tests conducted by E.P.A. (based on sampling emissions during sequences designed to simulate urban auto use) for 50,000 miles are reasonably good. But they greatly under-represent the number of cold starts that a car experiences in actual use. Since the more cold starts, the more emissions, emissions of cars in actual use exceed test emissions.
- Motorists are likely to maintain their cars less conscientiously than the "recommended" maintenance permitted manufacturers during the 50,000-mile test period — another reason why emissions in actual use will be higher than those in the tests.
- Though the 1970 Act instructed E.P.A. to encourage states to promote maintenance by car owners, little has been done. Only New Jersey requires annual emissions inspections of all cars.
- The absence of assembly-line tests has probably encouraged the manufacturers to provide selected models for certification.
- Recent in-use testing indicates that evaporative emissions from gas tanks and carburetors far exceed the standards. More realistic tests and better devices are needed.

Furthermore, attention has been focused too much on automobiles and not enough on other motor vehicles. For example, the 1970 Amendments instruct the E.P.A. to set standards for emissions from trucks and buses of any air pollutant which is a threat to public health and welfare; there is no mandated reduction of pollution such as applies to automobiles. The E.P.A. has moved only slowly to control trucks and buses: prior to 1974, diesel trucks were subject only to smoke standards, and gasoline trucks only to mild HC, CO, and NO_x standards. The interim 1975 standards permit new automobiles to emit only 17 per cent as many pollutants as uncontrolled cars; but light-duty trucks may emit roughly 25 per cent of uncontrolled-vehicle emissions, heavy-duty gasoline-powered trucks 27 per cent, and heavy-duty diesel engine trucks 75 per cent. Given those weak constraints, truck and bus emissions may now be as high as uncontrolled automobile emissions. Motorcycle emissions are not controlled at all, and standards are only now being proposed. Motorcycle emissions are therefore now three to four times those of a car meeting the 1975 standards. Accordingly, though the motorcycle fleet is only 1/20th the size of the automobile fleet, motorcycles now constitute a

significant source of emissions.

On the other hand, in one respect the present certification testing procedure for automobiles may be too rigid, since it requires that all cars pass the standards at all points up to 50,000 miles. Since average emissions (times the total number of cars) determine ambient air quality, a more logical approach would require only that the *average* emission over the entire 50,000 miles of all cars tested (weighted by likely sales) meet the standards.

The Failings of Process and Philosophy

Though we suspect that the program to control automotive emissions is less successful than it should be, a proper evaluation should depend on the answers to two questions: Are actual emissions from automobiles meeting the standards, or at least falling below the levels of uncontrolled vehicles? Is ambient air quality improving? If the answer to the first question is yes, then we know that ambient air quality is at least better than it otherwise would have been.

Data on CO and oxidants in ambient air indicate a modest downward trend from the late 1960s through 1974 in most metropolitan areas. In the absence of a complete model and complete data on weather changes and on other emissions sources, the role of auto emissions in this trend is difficult to assess. But there is one piece of circumstantial evidence to indicate that the auto emissions control program has played a role: ambient air quality with respect to NO_x has worsened; NO_x levels in the 1970s have definitely risen. The emissions control devices on cars built between 1968 and 1972 reduced only HC and CO emissions; they *increased* NO_x emissions (for which there were no standards) by at least 25 per cent. Thus, the improvements in CO and oxidant ambient air quality and the deterioration of NO_x ambient air quality are quite consistent with the expected results of the auto emissions controls.

The current emissions control program requires only that a presale sample of vehicles meet the standards. Limited information of actual emissions from vehicles in use has been collected by E.P.A. for local transportation control plans, and recently has E.P.A. reported that this in-use data may imply that automobile emissions are failing to meet the standards.

Most of this in-use data comes from automobiles whose owners are asked by mail if they will allow E.P.A. to test their vehicles (receiving a loan car for the few days involved, plus a small payment). There may be some bias toward clean cars, since owners of dirty cars may be reluctant to allow testing.

But despite this bias, a striking pattern emerges from a compilation of E.P.A. findings on samples of cars in various cities (*see page 58*). In every testing year and for every model year, average CO emissions significantly exceeded the applicable federal standards. In some testing years and for some model years, average HC emissions also significantly exceeded the standards. And 1973-model cars significantly exceeded the NO_x standards. Though the emissions from post-1967 cars were without exception less than those from uncontrolled (pre-1968) cars, these results cast serious doubt on the certification process for predicting in-use emissions.

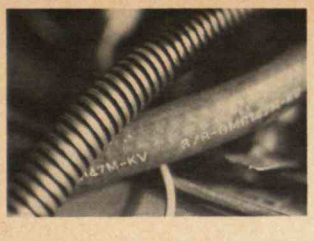
When the data are arranged so that emissions from a given model year can be tracked in subsequent testing years (*page 58*), a fairly consistent pattern shows that time and mileage take their toll in increased emissions.

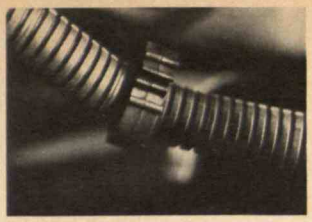
For 1972 through 1975, the certification procedure required that *all* models (rather than just the average) pass the E.P.A. test. As the table shows, this tougher certification requirement has also been a poor predictor of in-use emissions. The interim standards imposed in 1975 appear to be generating similar results. Average CO emissions of 1975-model cars significantly exceeded the standard in five cities, and only a third of the cars could meet all three standards. In Los Angeles, where the tougher California standards apply, most cars in use (74 per cent) met federal standards but average NO_x emissions exceeded the California standard.

Finally, in-use evaporative losses, set at 6 grams/test (or roughly 0.6 gram/mile) for 1971 (for 1970 in California) and then lowered to 2 grams/test (0.2 gram/mile) in 1972 and the years following, appear to be much greater than the standards. The federal testing procedure showed that 1970-71 cars in Los Angeles had evaporative emissions of 27.2 grams/test or 2.1 grams/mile; in Denver, 82.0 grams/test or 6.4 grams/mile. The Los Angeles emissions were 30 per cent below the emissions of uncontrolled cars, but these results nevertheless indicate that in-use evaporative HC emissions are serious and may exceed in-use HC exhaust emissions.

Overall, in-use emissions have exceeded and are likely to continue to exceed the federal standards by large amounts. The program simply is not working nearly as well as the certification procedures imply. The E.P.A.'s failure to encourage better maintenance on vehicles in use must count as a serious failing in the administration of the emissions control program. But failings in this and other areas seem to us to result from the general spirit and philosophy underlying the emissions control program: the notion held by Congress that the setting of specific, absolute, all-or-nothing emissions standards is the best way to deal with pollution problems.

In a world of certainty, where technology, costs, and benefits are well known and understood, the correct set of





standards would assure optimum emissions control. But in a world where benefits, costs, and technology are uncertain or even unknowable, absolute standards are much less likely to succeed. The goal under these circumstances should be to distribute the burden of control in a way that minimizes total social costs and at the same time creates incentives for research on new technology. In precisely these areas, the policy based on rigorous standards has failed — for several reasons:

☐ Standards create conflicting incentives for automobile manufacturers. If they wish to meet the deadlines, manufacturers must find quick technological solutions with a high probability of success, regardless of cost. Lower cost solutions which take more time or are less likely to succeed will be neglected. Catalytic converter technology was chosen by U.S. automakers to meet the original 1975 standards in just this way: it was a high-cost alternative, but it had a high probability of success. In retrospect, other solutions — riskier prospects in 1970 — might have succeeded. Foreign manufacturers have now demonstrated noncatalyst technologies that could meet the original 1975 standards (the Honda stratified-charge engine, the Mazda rotary engine, and the Peugeot diesel engine). It is not surprising that these developments came from overseas. These manufacturers did not depend entirely on the American market; they knew they would survive if their technologies failed and forced them to withdraw from the U.S. market for a year or two. They could afford to explore the higher-risk technologies. And they succeeded.

☐ The delays granted in the enforcement of the standards have undermined the credibility of the program. They have been granted at scattered and uncertain intervals; they have introduced needless uncertainty, which is simply not good policy.

☐ Standards regulating a number of pollutants simultaneously have impeded research. Most engine technologies involve trade-offs between emissions of HC and CO and those of NO_x; efforts to reduce the former frequently lead to increases in the latter. In the absence of a reliable technology for reducing NO_x emissions, exhaust gas recirculation must be used, despite its high penalty in fuel consumption. The NO_x standards have discouraged research on diesel and stratified-charge engines that could achieve low HC and CO emissions with high NO_x emissions.

☐ The standards policy has placed the burden of virtually all control efforts on the manufacturers. Incentives for motorists to maintain their cars properly are totally lacking. Furthermore, there is nothing to prevent motorists from disconnecting or readjusting the emissions control devices to improve the performance of their cars. Indeed, surveys in Washington, D.C., and New Jersey indicate that up to 15 per cent of 1970 to 1974 vehicles had one or more emissions control devices deactivated, and up to a third exhibited some form of tampering.

☐ The policy of standard-setting has institutionalized disregard for considering costs and benefits. It is shocking that the first full study of costs and benefits, with rigorous efforts to quantify and compare both, was conducted only in 1974 by the National Academies of Sciences and of Engineering, nine years after the start of the federal policy of standard-setting.

As economists, we are dismayed. We disagree with emissions standards that stress moral solutions over efficient ones. If alternative policies were not possible, we would grudgingly accept a modified version of the present program. But superior policies seem to us available, and we turn now to considering the most promising of them.

The Effluent Fee Program

Public policy ought to encourage private interests that serve and enhance social interests. Accordingly, a pollution control policy should reward manufacturers who produce clean cars and consumers who maintain their cars so as to keep them clean; it should penalize those who produce dirty cars or who allow them to become dirty. We propose a program of effluent fees to achieve these goals. Here are the details.

Effluent fees would be levied on all new cars sold (and, we hope, on all other motor vehicles on a comparable system) on the basis of measured emissions over 50,000 miles by a test sample of each make and model. Manufacturers would submit these vehicles before selling them as is done now; a small fleet would be tested for 50,000 miles and a larger fleet for 4,000 miles, with the results for the latter extrapolated to 50,000 miles as is done now. The *average* emissions for each model through 50,000 miles would be used to compute the effluent fee for that model, on the basis of the following formula:

$$\text{Fee} = F_{HC} \cdot HC + F_{CO} \cdot CO + F_{NO_x} \cdot NO_x,$$

where F_{HC}, F_{CO}, and F_{NO_x} are individual fees for hydrocarbons, carbon monoxide, and nitrous oxide emissions, respectively. The HC emissions would include evaporative and blow-by as well as combustion emissions.

The three fees should be set to equate the marginal benefits and marginal costs of abatement in each case. Data from the N.A.S. report suggests that the total fee should range from about $300 for an uncontrolled car in an area with minor pollution problems to about $900 for an uncontrolled car in an area with significant pollution prob-

lems. As a fairly realistic example, we propose the following fee schedules:

Low-pollution area:

F_{HC} = \$6.33/gram/mile
F_{CO} = \$1.14/gram/mile
F_{NO_x} = \$25.00/gram/mile

High-pollution area:

F_{HC} = \$19.00/gram/mile
F_{CO} = \$3.45/gram/mile
F_{NO_x} = \$75.00/gram/mile

For an uncontrolled car, the total fee in a low-pollution area would be about \$300. The fee for a car that meets 1975 interim standards in the same area would be \$106, while the extra cost to the manufacturer of equipping the car to meet these standards is estimated at \$280. The fees (*see page 63*) are thus designed to encourage manufacturers to build cars that meet the 1970 standards for low-pollution areas and the 1975 California standards for high-pollution areas.

Although we show fee schedules differing between regions, we suggest a single federal schedule for all new cars at the level of the low-pollution area, with each state permitted to add extra effluent fees of its own on cars it registers. States with few pollution problems or whose citizens do not care about pollution would be free to abstain from additional effluent fees. States which wished to differentiate their fees by county or administrative district would be free to do so. Adjoining states which share an urban area would be encouraged to coordinate and equalize their fees. If "bootlegging" of new cars from low-fee to high-fee states became a problem, there is an easy solution: effluent fees paid to another state could count as an offset up to the amount due to the state of registration. This method is now used for state income taxes on individuals who work in one state and reside in another.

Comparable federal and state fee schedules should apply to all sources of emissions, mobile and stationary. Since the important measurement is emissions over time, comparability on this basis should be the goal. For example, if an average car travels 12,000 miles per year and an average truck 20,000 miles, the truck fees should be 20/12 of those for cars. The stationary source fees should be similarly calculated. The fee schedule could be expanded at any time to include other harmful pollutants, such as lead compounds or sulfur oxides.

All emissions control devices, actual and proposed, deteriorate and require maintenance. As we have seen, today's programs offer no incentives for maintenance, and a car owner may even gain from degrading his or her system. Clearly, an inspection-maintenance regime would yield significant decreases in emissions. Accordingly, an effluent fee system on cars in use would be a valuable part of an emissions control program. We propose that each state be encouraged to establish emissions inspection-testing procedures and an effluent fee schedule, similar in form to that described for new cars, to be levied on the basis of annual test results. States without serious pollution or whose citizens do not care about pollution would be free to forego inspecting and taxing entirely.

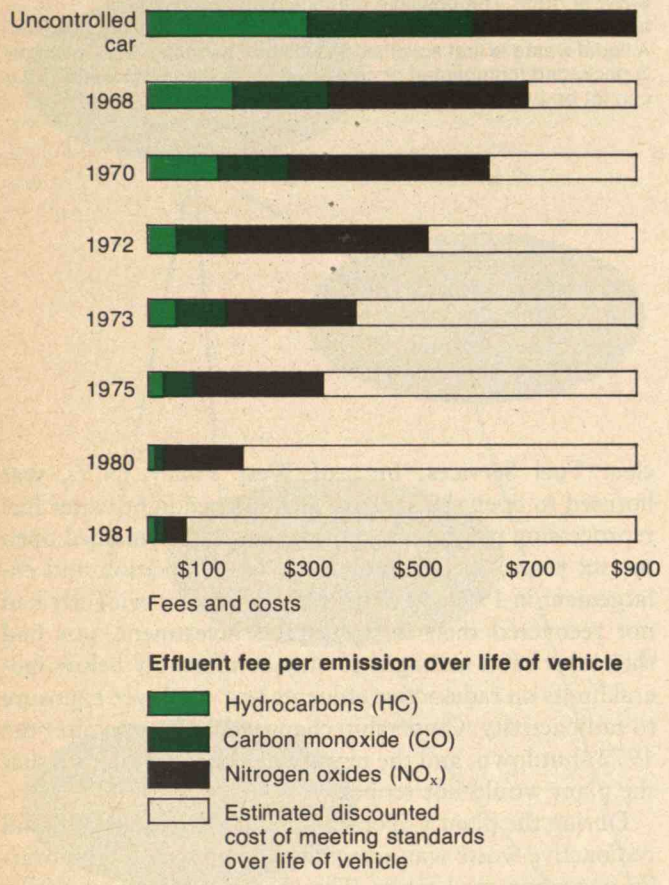
The fee schedule should be based on annual mileage as well as on the emissions per mile. For example, with a schedule of F_{HC} = 0.0106¢/gram/mile, an uncontrolled car driven 12,000 miles in a year would pay \$60; the same car, if it could meet the original 1975 standards, would pay only \$12. This should provide adequate incentives for maintenance, and it would penalize the very high emitters.

The states should be encouraged to institute the same program for all motor vehicles and a similar one for stationary sources. Effluent fee schedules such as we have proposed, unlike the current program, would provide the right incentives for research, low-cost production, and proper maintenance. They would introduce vital elements of competition and flexibility into the national program. Manufacturers and owners of clean cars would be rewarded and those of dirty cars would be penalized.

Our program would shift manufacturers' incentives from political lobbying and brinkmanship, where their interests clash with those of the rest of society, toward designing and building lower-cost and cleaner cars, where the interests of automakers and society coincide. Manufacturers would be rewarded for producing clean cars and for producing durable and easily-maintained control devices. They would also have incentives to plan and pursue research on emissions control, pursuing riskier strategies if the expected value of the strategy were positive. They would be able to trade off among pollutants, choosing low-cost strategies especially useful for reducing some pollutants even if they could not reduce others. Difficulties in reducing emissions of one pollutant would not hold up the production of low-cost engines that are very effective in reducing other pollutants. All of these actions would be consistent with an efficient allocation of resources and the rapid and efficient production of new knowledge about emissions control. The proposed effluent fees would lead naturally to the greatest abatement in those cars and by those manufacturers for which abatement is least expensive.

Consumers would have incentives to buy and maintain clean cars and to use additional cost-effective retrofit devices as they became available. Manufacturers would

A proposal for effluent fees to replace automotive emissions controls as a method of regulating air pollution in the U.S. Vehicles would be tested for emissions of pollutants and fees would be paid by their owners on the basis of the results. The fees would provide an incentive for the purchase of nonpolluting vehicles, and annual inspections would assure that emissions control systems were maintained in proper operating condition. The estimated discounted cost of that maintenance is added to the fees to show the total costs for meeting standards in the life of the vehicle.



have an incentive to compete for consumers on the basis of the emissions of their cars, and consumer publications as well as federal tests could help consumers evaluate competing claims.

We believe such an emissions fee program would be less regressive in its income consequences than the current program. This is because most poor people live in rural areas and states where the need for emissions control is less pressing and effluent fees are likely to be low.

The administrative costs of our proposed program should not be large. The new care effluent fee program should not cost more than the current program. The used car program would involve added expense, although in most states with annual or semi-annual safety inspection programs the added costs for manpower and equipment for emissions tests would probably be small — less than $1 per car.

The extra repair costs, less fuel savings, are more difficult to estimate. One study shows that maintenance repairs costing $27 to $37 per car yielded a 44-per-cent reduction in HC emissions and 34-to-43-per-cent reductions in CO emissions on dirty cars. If new-car owners pay effluent fees averaging $100 per car, annual sales of 10 to 12 million new cars mean $1.0 to $1.2 billion in extra federal revenues. If 35 million cars in use pay an average of $10 per car, $350 million is generated for the states.

How should these funds be used? Though in general earmarking is a bad fiscal principle, it probably would have little distorting effect in this case. The federal government spends more on pollution control (mostly for waste treatment plants and research) than this estimate of collections from a motor vehicle fee program, and the same is probably true of most states. Careful earmarking of emissions fee revenues for pollution control purposes could be appropriate.

The effluent fee program we propose is simple and direct. It would motivate both the auto industry and consumer to take socially beneficial actions at the lowest cost possible. It would encourage the proper research. It would decrease the large indirect costs of bureaucratic controls and result in a pervasive emphasis on producing and maintaining cleaner cars.

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Nuclear Waste Disposal: Not In My Backyard

Technology to solve the waste disposal problem is at hand. But while we hammer out safety standards to govern its use, spent fuel continues to accumulate.

Chart at right: The possible management and disposal technologies for low- and intermediate-level and cladding wastes. A liquid waste is first solidified to facilitate handling; a solid waste is packaged (compacted or cemented with other solid wastes) if it cannot be burned. All such wastes are destined for burial.

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". . . If the average person, otherwise vaguely favorable to nuclear energy, is asked what he thinks about the future of this source, he is most likely to mention waste disposal as the big unsolved problem. . . . The other issues . . . reactor accidents, diversion or theft of fissionable materials, routine radioactive emissions, thermal pollution . . . have tended to come and go. . . . I would predict that, should nuclear energy ultimately prove to be socially unacceptable, it will be primarily because of the public's perception of the waste disposal problem."

— Harvey Brooks, July, 1976

There is much evidence to support Dr. Brooks' speculation. Among the controversies surrounding atomic energy, the question of what to do with nuclear waste has become the most volatile, capturing public attention and carrying the debate over nuclear energy beyond science and technology into politics and ethics. Yet until now, most discussion of nuclear power has concentrated almost exclusively on technological issues.

Our discussion must necessarily begin with technology: the contours of the waste management and disposal problem are largely determined by the method we choose to generate nuclear power. An important choice arises between a fuel cycle that entails no reprocessing and one in which the fissionable material from the reactor's spent fuel is salvaged.

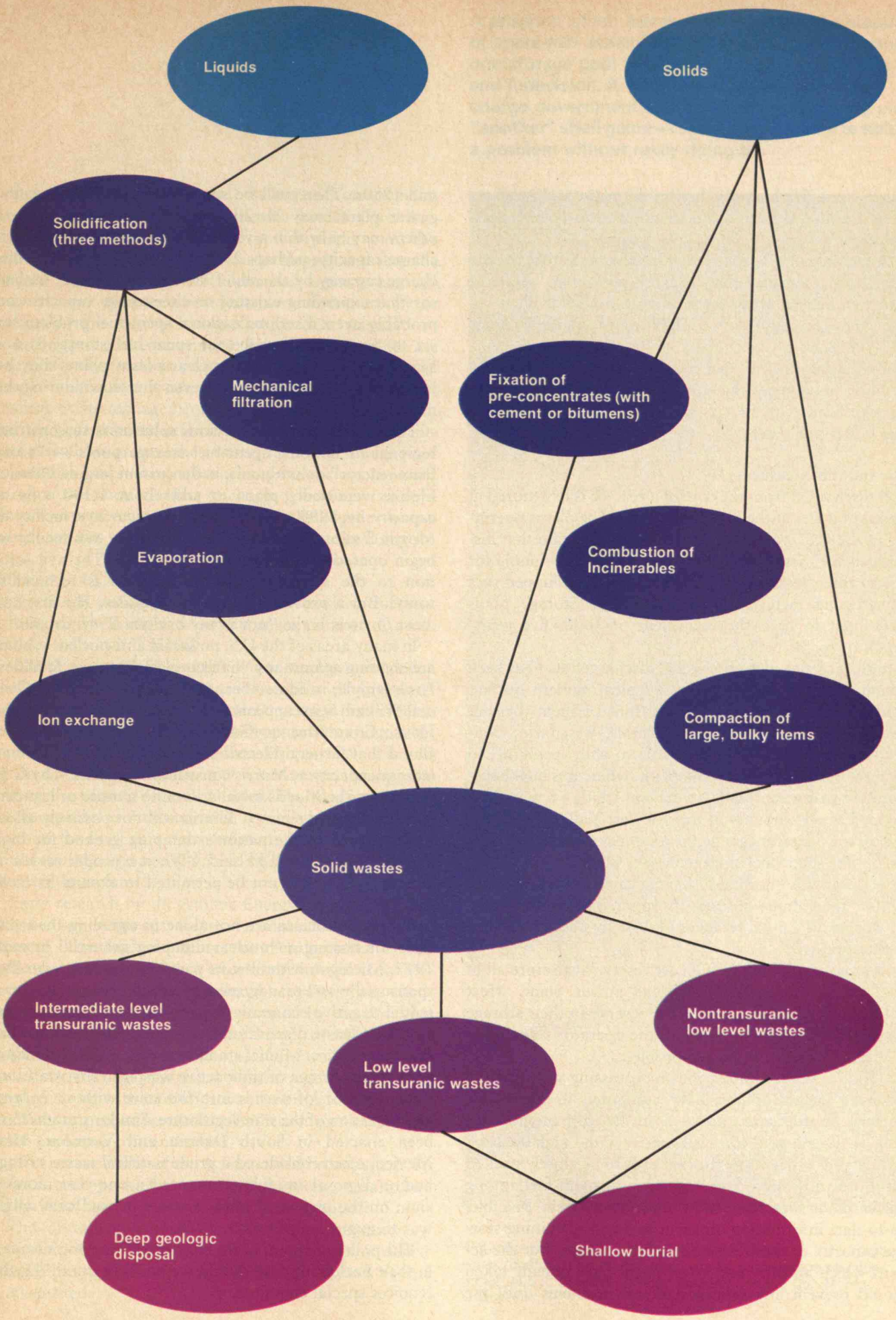
Government and industry have always worked under the assumption that reprocessing plants would be built as soon as enough reactors came into service to support them economically. Public and private decisionmakers have therefore tended to favor the reprocessing fuel cycle, and they postponed certain technical decisions about nuclear waste management and disposal until the time when large-scale fuel processing could begin.

But that time has not yet come, and reprocessing technology has yet to come of age. Even the first commercial reprocessing attempts in 1966 were not trouble-free. Nuclear Fuel Services, Inc., of West Valley, N.Y., was licensed to open the first privately-owned light-water fuel reprocessing plant in the world. The plant remained open for six years, until it was closed for renovation and enlargement in 1972. At that time, the owners evidently had not recovered their initial capital investment, nor had their operation managed to stay comfortably below federal limits on radioactive effluents and employee exposure to radioactivity. Ownership changed hands soon after the 1972 shutdown, and the new owner later announced that the plant would not reopen.

During the plant's operation, 600,000 gallons of liquid radioactive waste was accumulated and stored temporarily in carbon-steel tanks. The chemical treatment of the waste in the tanks produced a liquid and "sludge" mixture, which complicates the problem of final disposal. Obviously the tanks will eventually corrode. Yet decisions on disposal and treatment, and responsibility for the costs, have been delayed and disputed. The waste lies there still. Estimates of the time and money needed for its disposal run from 10 to 15 years, and up to several hundred million dollars.

America's second commercial reprocessing project was also unsuccessful. In the late 1960s, General Electric built a facility at Morris, Ill. The plant's design incorporated a novel variation of the same process the American government used to recover weapons-grade plutonium from nuclear waste. But the new process was a technical failure; in 1974 the company suspended all work at Morris.

By the end of last year, the reprocessing facility owned and operated by the French government at Le Hague to reprocess spent light-water fuels was the only commercial-scale reprocessing plant operating in the West. That plant was modified in 1969; previously it had reprocessed only gas-graphite reactor fuels. The British reprocessing plant at Windscale was closed in 1973, and plans to enlarge that facility have been set aside pending litigation. The only other U.S. facility, at Barnwell, S.C., re-


Liquids
Solids
Solidification (three methods)
Mechanical filtration
Fixation of pre-concentrates (with cement or bitumens)
Evaporation
Combustion of Incinerables
Ion exchange
Compaction of large, bulky items
Solid wastes
Intermediate level transuranic wastes
Low level transuranic wastes
Nontransuranic low level wastes
Deep geologic disposal
Shallow burial

quires some finishing touches on the plant and a revised federal policy before it will be allowed to begin operations.

In October, 1976, the Ford administration told the nuclear power industry that, because plutonium holds the threat of nuclear weapons proliferation and/or illicit seizure, the U.S. might soon prohibit reprocessing. In April, 1977, President Carter made good this warning, effectively halting nuclear fuel reprocessing in the U.S. Government policy may change once again, but until it does no significant commercial-scale reprocessing of reactor fuel will occur here.

The Interim Measure

Fuel discharged from the core of a reactor is first stored in a pool of water at the power plant site. The plants operating in the U.S. were designed on the assumption that discharged fuel assemblies, after cooling in these pools for one to three years, would be packaged and shipped to a reprocessing facility. Accordingly, most storage pools were built to hold the equivalent of about five years' worth of spent fuel.

In the absence of reprocessing, discharged fuel has been accumulating in these pools. (A typical modern nuclear power plant discharges about 30 tons of spent fuel per year.) Some electric utilities in Illinois, Wisconsin, Connecticut, and California were able to ship spent fuel to General Electric's Morris, Ill., plant, where it is now being stored in vast water pools. In the late 1960s a few utilities shipped small amounts of fuel to West Valley, N.Y.

Reactor operators gauge the amount of space available for on-site spent-fuel storage in two ways:

☐ A pool with "normal discharge capacity" can accommodate the volume of spent fuel discharged from a reactor during an annual refueling — usually about one-third of the total core.

☐ A storage pool with "full core reserve" can store all of the fuel in an operating nuclear power plant. Most utilities like to maintain full core reserve in their storage pools; this availability increases the operator's flexibility in dealing with maintenance problems.

Without any likelihood that reprocessing will begin in the near future, utilities have attempted to retain this capacity for full core reserve. Their favorite method has been to expand pool storage capacity with "high density" storage racks that allow the fuel rods to be closely packed without overheating. Some transfers of spent fuel among power plant sites have been reported as well. Reliable, up-to-date information on spent fuel and remaining storage capacity in the U.S. is difficult to obtain. But the actions which industry and government have already taken should prevent any serious national problems until the mid-1980s. There will be some local exceptions: a few power plants may already have lost full core reserve; others may be within a year or two of losing normal discharge capacity; perhaps 25 plants could lose normal discharge capacity by the mid-1980s. But in general, we can say that expanding existing on-site storage capacity can probably avert a serious national spent-fuel problem for six to ten years. If space for spent-fuel storage is not found in that time, many nuclear power plants may be forced to reduce operations or even shut down during the mid-to-late 1980s.

Technically, the most obvious solution is to construct regional or national spent-fuel storage pools — "away from reactor" or AFR pools, in the current jargon. General Electric reportedly plans to add about 1,100 tons of capacity by 1980 to its 700-ton de facto AFR facility at Morris. Exxon plans to build a 7,000-ton AFR facility to begin operation between 1982 and 1984. The AFR solution to the spent-fuel storage problem is technically sound. But it provokes two political issues. The first and most obvious is the "not in my backyard" syndrome.

In many areas of the U.S. powerful anti-nuclear lobbies are aligning against any "nuclear waste" storage facilities. For example, in September, 1977, Illinois Attorney General William Scott appeared before a Subcommittee of the House Committee on Government Operations. He declared that General Electric's plans to increase spent-fuel storage capacity at Morris constituted "a decision by G.E. to convert the Morris installation into a more or less permanent disposal site. . . . Illinois will not passively allow itself to become the nation's dumping ground for high level nuclear waste," he said. "When a proper review is complete, G.E. will not be permitted to expand its facility."

Illinois politicians are not alone in signaling their distaste for hosting a "nuclear dumping ground." In mid-1977, Michigan withdrew its participation in a federally-sponsored waste management program because of its potential negative economic impacts and the likely unsuitability of waste disposal in the geologic formations near the Great Lakes. Minnesota has enacted a law forbidding permanent storage of radioactive wastes in that state *and* transportation of wastes into the state without express authorization of the state legislature. Similar statutes have been enacted in South Dakota and Vermont. New Mexico, often considered a prime national waste storage and/or disposal candidate, imposed a one-year moratorium on the import of nuclear waste in any form which was to expire on March 1, 1978.

The political appeal of the slogan, "If they don't want it in their backyard, why should we put it in ours?" hardly requires special emphasis.

A program which merely orchestrates the shipping of spent-fuel assemblies around the country from one storage pool to another *looks like* confusion and indecision. It would surely invite critics to charge government and industry with carrying out "another" shell game — one which appears to solve a problem without really doing so.

But the "not in my backyard" issue is only one of many hurdles facing AFRs. A new California state law prohibits future construction of nuclear power plants until the state "finds that there has been developed, and that the United States through its authorized agency has approved, and there exists a demonstrated technology or means for the disposal of high-level nuclear waste."

In this political environment, AFR storage facilities are too easily dismissed as prevarication and deferral of the "real" radioactive waste disposal problem. A national nuclear waste management and isolation program which for ten years merely orchestrates the shipping of spent-fuel assemblies around the country from one storage pool to another *looks like* confusion and indecision. It would surely invite nuclear critics to charge government and industry with carrying out "another" shell game — one which appears to solve a problem without really doing so.

A Swarm of Choices

Government and industry are already sensitive to these criticisms. They are now considering a number of alternatives for waste disposal.

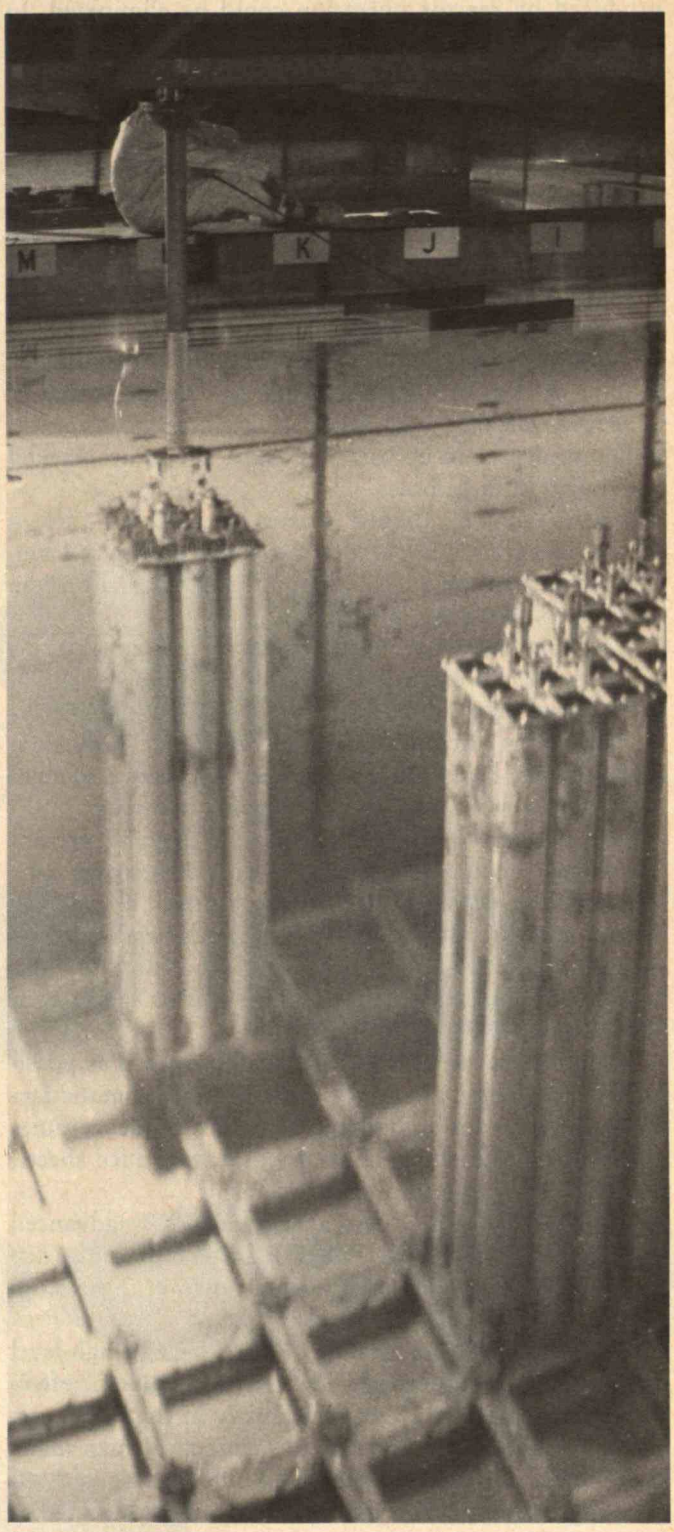
The Department of Energy's waste management policy seems to be evolving toward isolation of high-level radioactive wastes within "stable" geologic formations, in media reachable through conventional mining techniques. Such a facility — in effect a super AFR — would by design allow retrieval of the waste materials any time during the coming several decades. The idea is to lower the encapsulated waste material down vertical shafts into holes in the floor of a conventionally mined cavern. The waste would come to rest several hundred meters beneath the earth's surface.

Early research by the Atomic Energy Commission emphasized salt as the best disposal medium for a super AFR. Because of its high solubility, the mere presence of salt indicates geologic stability over long time periods. Recently a number of apparent drawbacks have been cited. For example, thermal gradients caused by the decaying radioactive material could draw brine through the salt toward the waste cannisters. Contact with this brine could corrode the cannister within a few years after emplacement, with two undesirable consequences:

☐ Without proper ventilation, hydrogen gas could build up to explosive concentrations.

☐ The retrievability of the wastes could be impaired. To by-pass such problems, granite formations, basalt, and shales have been suggested as alternatives to salt.

The argument within the technical community — about the various trade-offs among these media, and their relative merits given alternative disposal schemes — has been spirited.



A storage basket containing the spent-fuel assembly from a boiling water reactor being maneuvered into its final storage position under 28.5 ft. of water. (Photo: General Electric Co., Morris Operation)

The salt versus granite debate, by no means the only "live" technical issue in waste management and disposal, may be the most intense. Even a casual survey of the available technical literature on nuclear waste isolation reveals an impressive array of technical alternatives.

Everyone agrees that the whole radioactive waste problem would be greatly simplified if the actinides (eg. thorium, actinum, neptunium, americium, and curium) produced by reactor operation could be eliminated. In principle, this could be done either by disposal in deep space or by transmutation through bombardment by subatomic particles — in either a particle accelerator or a reactor core. However, neither of these options is technically and economically feasible in the foreseeable future.

Other schemes fall into two general categories. These are termed "retrievable" and "non-retrievable" disposal.

Several purportedly "non-retrievable" disposal schemes have been proposed, among them:

☐ *solution-mined cavities:* Chemical solutions are used to mine cavities in soluble geologic media (rock salt).

☐ *drilled-hole matrices:* A grid of large-diameter holes is drilled to depths of up to 2 km. Solid wastes are packed and sealed in these holes.

☐ *hydrofracture:* Liquid wastes are mixed into a cement-like grout and pumped into shale as deep as 1 km. The pressure of the injected grout produces cracks in the media into which the mixture flows.

☐ *deep-well injection:* Similar to hydrofracture. Wastes are pumped into existing or newly drilled wells.

☐ *rock melting:* Liquid wastes are poured into a subterranean cavity formed by an underground explosion. Radioactivity heats the wastes; they boil dry and melt with some surrounding rock into glassy hardness.

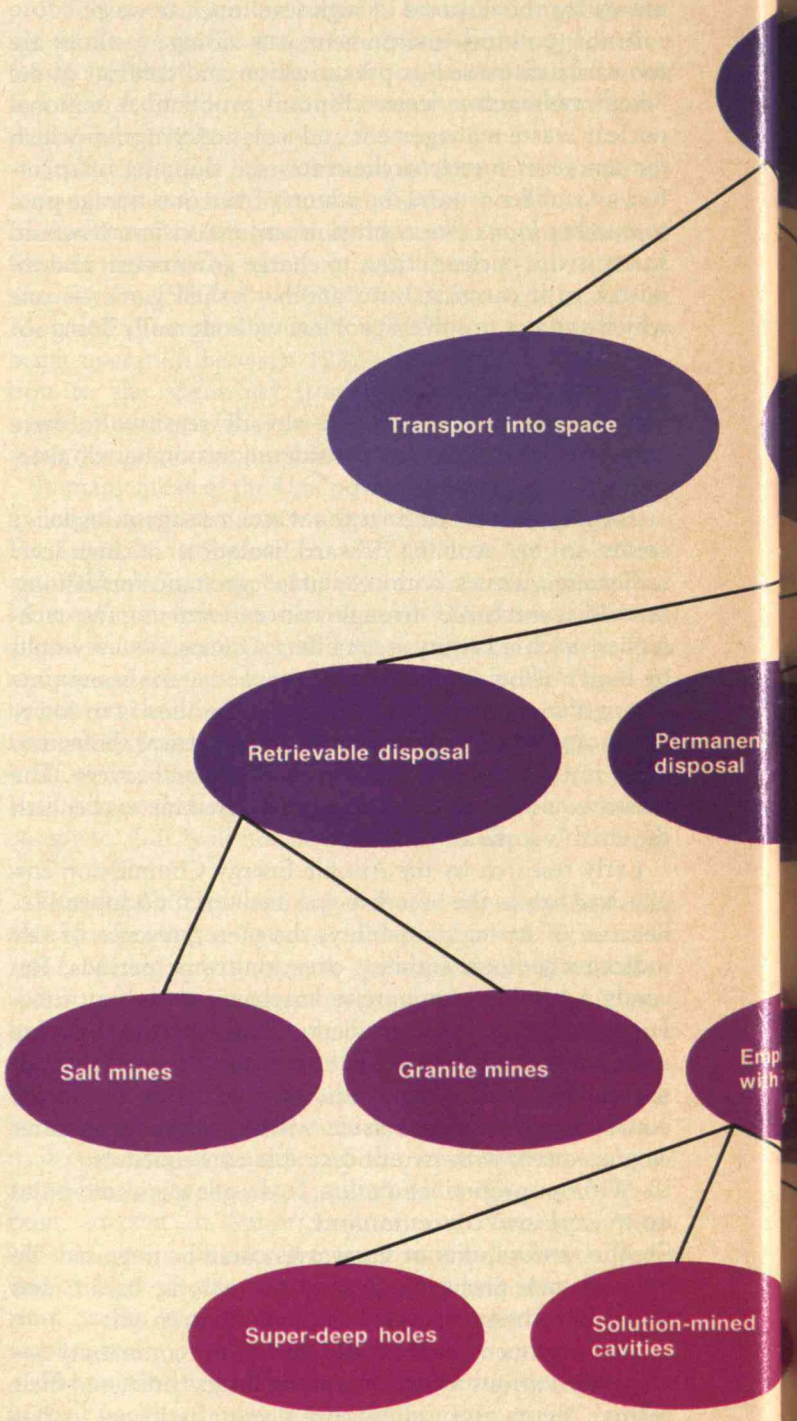
Each of these options is either at or beyond present limitations of equipment and know-how. Moreover, none is actually "non-retrievable" waste disposal. To varying degrees each greatly complicates and adds expense to retrieval; none provides absolute protection from accidental release into the biosphere or eliminates the risk of human mischief.

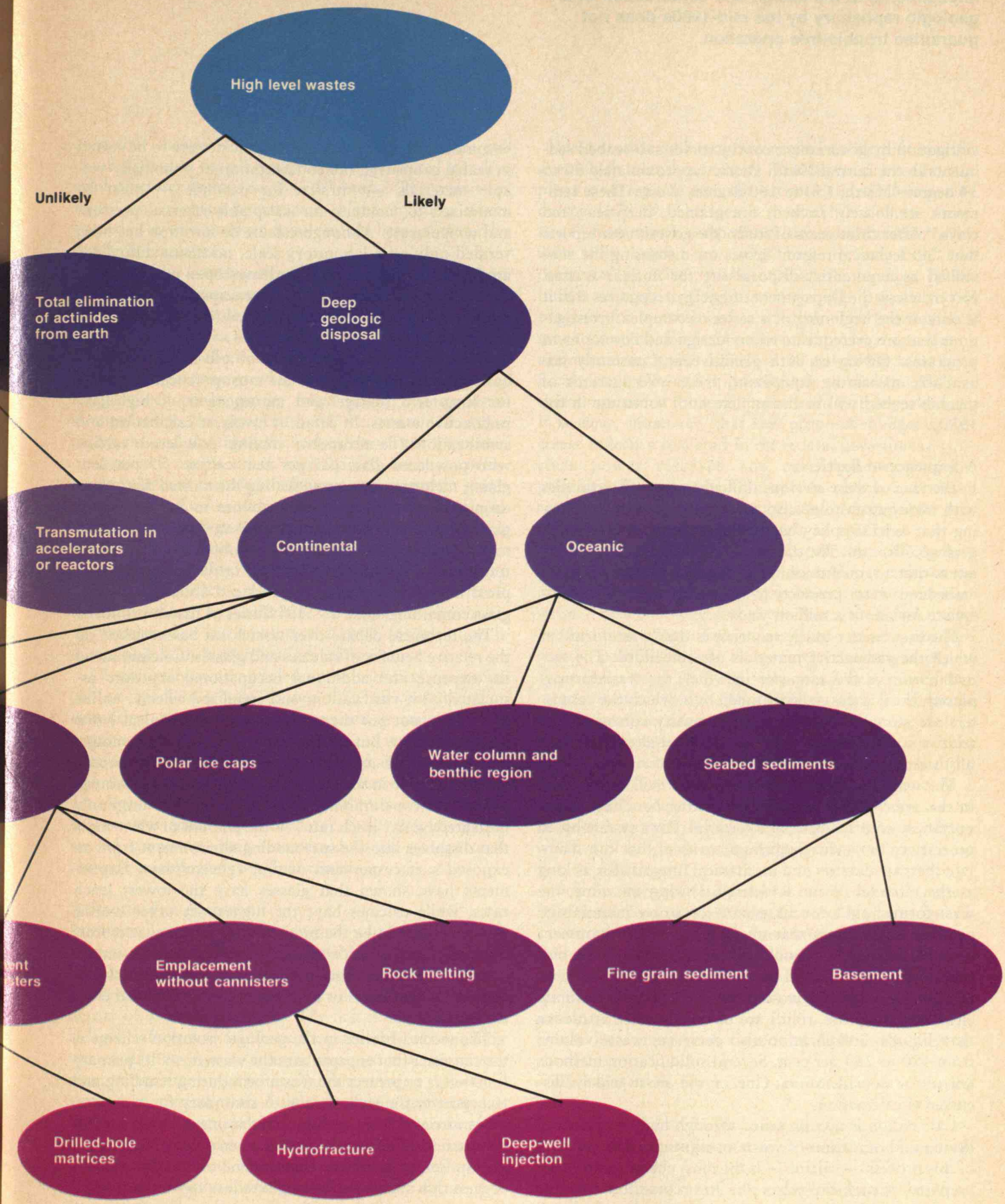
The polar ice sheets have also been proposed as possible nuclear dumping grounds. But uncertain climatic factors and ice sheet stability, and unknown residence times of both ice- and glacier-derived water within ice sheets, now make this solution impractical.

Recent advances in deep-sea technology have advanced hopes that the ocean bed might provide alternative disposal repositories. The government, however, has recognized the obvious problems. The *Seabed Disposal Program Annual Report* states that, "Placing high-level wastes on the seafloor, i.e., in the water column, effectively puts the waste contained directly in the biosphere. Since it is difficult to conceive of a practical man-made waste form/ container system that would survive without releasing radionuclides for hundreds of thousands of years in a marine environment (or any environment), one must assume the radioactive material would eventually enter the ecosystem."

An alternative ocean geologic medium now under in-

Some of the possible management and disposal technologies for high-level waste are being explored more vigorously than others. The ideal management technologies — transport into space and transmutation — are the least likely. More practical are undersea and underground burial.




High level wastes
Unlikely
Likely
Total elimination of actinides from earth
Deep geologic disposal
Transmutation in accelerators or reactors
Continental
Oceanic
Polar ice caps
Water column and benthic region
Seabed sediments
Emplacement without cannisters
Rock melting
Fine grain sediment
Basement
Drilled-hole matrices
Hydrofracture
Deep-well injection

The absence of major technical or economic impediments to the design and construction of a geologic repository by the mid-1980s does not guarantee trouble-free operation.

vestigation by government contractors is sub-seabed sediments in the central North Pacific (approximately 30 to 34 degrees North, 150 to 160 degrees West). These sediments are loosely packed, fine-grained, deep-sea "red clays." After three years of study, the government reports that "no technical reason" exists for dismissing the sub-seabed as a potential disposal site for nuclear wastes. Nevertheless, the Department of Energy recognizes that it is only at the beginning of a series of complex investigations that are prerequisite to any design and development programs. Owing to both primitive and currently unavailable measuring equipment, these investigations of the sub-seabed will be incomplete until sometime in the 1980s.

A Sequence of Barriers

In the face of these obvious difficulties and uncertainties with "non-retrievable" disposal schemes, it is not surprising that federal policy has begun to favor "retrievable" geologic disposal. The theory of retrievable geologic storage is that a sequence of barriers must be erected around embedded waste products to isolate them from the biosphere for about a million years.

The first barrier of the sequence is the "wasteform" in which the radioactive materials are embedded. The second barrier is the cannister in which the wasteform is placed; third is the geologic medium in which the cannisters are stored. At this time, controversy surrounds the relative economic and technical merits of alternatives for all three.

The wasteform's characteristics must isolate the waste in the event of cannister failure during handling, transportation, emplacement, and retrieval. For a system based on retrievability, this requires a material that can maintain thermal stability and mechanical integrity for as long as the retrieval option is desired. During this time, the wasteform should not release any corrosive materials or produce any stresses that might affect the containment vessel. If an accident should expose the waste to the biosphere, the waste should be confined to as small an area as possible, and the wasteform itself should facilitate clean-up. Therefore, solids are obviously more attractive than liquids. Solidification also decreases waste volume from 150 to 250 per cent. Several solidification methods are under consideration. One of the most widely discussed is calcination.

Calcination is accomplished through high temperature drying and oxidation of waste precipitates. The product of this process — calcine — is the most cheaply and easily prepared wasteform. Also, the low corrosion rates of stainless steel cannisters holding calcine indicates that it can be stored for long periods before internal corrosion becomes significant. However, if calcines are to be stored in sealed cannisters, the concentration of potentially volatile materials — nitrates, for example — must be minimized to maintain an acceptable internal pressure and temperature. Although calcine de-nitration has been verified only on a laboratory scale, no major difficulties are foreseen. Stabilized calcine leaves open many options for further treatment: it can be encapsulated, incorporated into metal matrices, or vitrified (converted to glass or ceramic).

Vitrification, while the subject of a lively technical debate, appears to many to be the most practical technique for long-term storage and management of high-level radioactive wastes. In detail, it involves: calcination and stabilization (de-nitration); mixing powdered calcine with powdered glass (25 per cent calcine, 75 per cent glass); melting; casting and sealing the molten mixture in cannisters; and allowing the mixture to harden into a glass monolith. Temporary storage of the metal-encapsulated glass for thermal cooling would precede transport to a long-term storage facility. A pilot-scale plant in France has already produced about 12 tons of glass containing some 5×10^6 Curies of fission products.

The technical debate over wasteform has centered on the relative benefits of calcines and glasses. Calcines avoid the expense and additional occupational exposure associated with vitrification; and stabilized calcine, unlike glass, does not put thermally-induced mechanical stress on its container. But calcine has one major disadvantage: in the event of an accident, powdered calcine would readily disperse in the atmosphere and dissolve in water.

The relative durability of a wasteform is commonly measured by its "leach rate" — the amount of waste mass that dissolves into the surrounding environment from an exposed surface per unit of time ($gm/cm^2/day$). Experiments have shown that glasses have the lowest leach rates, while calcines have the highest. In other words, glasses appear to be the most *durable* of the wasteforms currently under consideration. There are, however, uncertainties in extrapolating the available experimental evidence to longer times or to different hydro-chemical environments.

The second barrier in the geologic isolation scheme is the cannister that encapsulates the wasteform. Its primary function is to protect the wasteform during handling and transport to the geologic site. A secondary function is to allow retrieval from geologic emplacement and to protect the wasteform during the period when policymakers want the option of retrieval. Department of Energy officials suggest that such a period ought to last approximately 50 years.

Thus waste cannisters must be able to resist attack by

corrosive chemicals (saltmine brine, for example, can cause structural deterioration of an unprotected stainless steel cannister in far less than 50 years). The cannisters must also withstand extremely high radiation fluxes caused by fission-product decay and the heat generated by the decaying wastes.

Because the wastes generate extreme heat during their initial decade of confinement, a key decision is when to encapsulate the wastes (in whatever form) in storage cannisters. This decision depends upon: the cannister cooling method; the limiting cannister wall temperature (i.e. the temperature at which the cannister's mechanical integrity can no longer be relied upon); the cannister configuration; the properties of the contained waste materials; and the thermal conductivity of the cannister.

Cannisters can be air- or water-cooled. Because cannister surface heat transfer coefficients are greater in water than in air, water-cooling would allow higher heat generation rates and, in turn, fewer cannisters required for storage. The cylinder and the annulus are two geometric configurations being considered for waste cannisters. Since an annulus has a relatively larger surface area than a cylinder whose circumference is equal to the outer circumference of the annulus, the latter configuration is compatible with higher heat generation rates.

Theoretically, water-cooled and/or annular cannisters can encapsulate wastes sooner than air-cooled and/or cylindrical cannisters, possibly as soon as one year after reactor discharge. There are economic as well as safety issues here: the choice of cooling method and cannister design determines the number of cannisters to be managed. To minimize cannister management costs, some suggest that wastes should be stored for two years in water-cooled cannisters, then transferred to air storage until they are transported to a final repository.

A Standard of Agreement

Prudence dictates that we plan for limited cannister and wasteform durability. So the main barrier in all multibarrier isolation schemes is a geologic structure. The government appears to be using three criteria to define the integrity of disposal structures. The first is emplacement at a depth sufficient to minimize the possibility of breaching due to natural events (tectonic or igneous activity, erosion, meteorite impact), or human activity (sabotage, vandalism, nuclear war, drilling by future generations). Second, the medium should be devoid of or low enough in mineral concentrations so that the possibility of inadvertant breach caused by future exploratory efforts is minimized. Finally, present and probable future hydrogeologic boundaries should obstruct transport of radionuclides to the biosphere.

Field studies and tests are needed to identify specific sites which meet these criteria. The Department of Energy plans to investigate a number of rock and salt formations during 1978-79. The idea is to establish a "mix of options" from which a repository site could be selected by early 1980. Construction would begin by early 1982, and operation by 1985. President Carter's January, 1978, budget message to Congress assigns high priority to the program for meeting such a schedule. The President has asked Congress for $163 million for nuclear waste management in fiscal year 1979 — a 29 per cent increase over fiscal year 1978, and approximately double the proportional increase in the total Department of Energy budget. It is clear, moreover, that this proposed budgetary increase reflects a real shift in the federal government's nuclear power research and development program priorities. The Carter administration plainly intends to try to meet the requirements of the California state law and other similar demands as soon as possible.

The central premise of the Department of Energy's proposed isolation and storage schedule is that the waste management problem is not technical in the standard sense. The technology and know-how is well in hand to proceed with a more sophisticated disposal program with greater political appeal than merely shuffling racks of spent fuel assemblies from one pool of water to another — provided that some options are retained for response to additional data and experience. In other words, there is no technical impediment to a "super AFR" site selection, design, and construction program in operation by the mid-1980s. Nor is economics an issue. The cost of a "super AFR" would be a tiny fraction — probably on the order of 1 per cent or less — of the value of the electricity which will be produced by presently operating nuclear power plants.

But the absence of major technical or economic impediments to the design and construction of a geologic repository by the mid-1980s does not guarantee a trouble-free operation. For the blunt fact is that some obvious political questions remain unanswered. For example:

☐ What is *adequate* nuclear waste management and disposal?

☐ For how many years *should* cannister integrity be assured?

☐ If leakage does occur, what is an *acceptable* migration rate?

☐ What is a *low enough* probability of breach?

☐ Who *should* pay "insurance premiums" and how large should they be?

In short, "How safe is safe enough?" A wide variety of standards could in principle be applied to any repository design to indicate "adequate" safety. It's important to

stress that the point is not the technical or economic trade-offs between salt and granite, or between water-cooled annular cannisters and air-cooled cylindrical ones. These questions, important as they are, are secondary to agreement on a comprehensive and specific set of standards which answer the question above. Throughout the history of nuclear power plant construction in the U.S., plants have been built before that question had been resolved to everyone's satisfaction. The result is well known: delays, equipment retrofits, uncertainties, and cost increases. This experience argues for caution about designing and building a nuclear waste repository before there exists a broad and explicit concensus on what we want that facility to accomplish.

Compromise will be necessary to achieve this concensus. The critics of nuclear power will have to resist putting government and the nuclear industry in the impossible position of "demonstrating" something which by definition would take centuries or longer. And the nuclear industry must resist the temptation to rush ahead with a hardware and construction program in order to claim that "the problem has been solved."

The Carter administration shows good sense in its attempt to avoid a lengthy and inconclusive debate over the technical and economic trade-offs among the swarm of different isolation and disposal schemes. There is a strong case for giving top priority now to completion of a retrievable, deep geologic repository by the mid-1980s. But this is a very tight schedule: the development of an explicit concensus among nuclear critics as well as among nuclear advocates on the standards which define such a facility's safety is a complex political problem which will take time. It will almost certainly take more time than has been allowed.

This means that while we determine "how safe is safe enough" for a repository, the government may simultaneously have to find some politically acceptable *interim* measures to deal with the spent-fuel storage problem. The Department of Energy can hardly dismiss the concerns of Illinois and other states reluctant to open their backyards to spent fuel.

Classification of Radioactive Waste from Power Plant and Reprocessing Operations

High level wastes (HLW)

Wastes that contain 99.9 per cent of the nonvolatile fission products, 0.5 per cent of the uranium and plutonium, and all the other actinides formed by the transmutation of uranium and plutonium in reactors. HLW are the aqueous wastes resulting from reprocessing or the spent-fuel rods to be disposed of in the absence of reprocessing.

Cladding wastes (CW)

Solid fragments of zircalloy and stainless steel cladding (the tube in which the fuel is placed) and other structural components of the fuel assemblies that remain after the final cores have been dissolved.

Low level transuranic wastes (LLW-TRU)

Solid or solidified materials which contain plutonium or other long-lived alpha-particle emitters in known or suspected concentrations higher than 10 nCi/g (nanoCuries per gram) and external radiation levels after packaging low enough to permit direct handling.

Intermediate level transuranic wastes (ILW-TRU)

Solid or solidified materials which contain long-lived alpha-particle emitters at concentrations greater than 10 nCi/g and which have, after packaging, typical surface dose rates between 10 and 1,000 mrems/hour due to fission product contamination.

Nontransuranic low level waste (LLW)

Diverse materials which are contaminated with low levels of beta-and gamma-emitting isotopes but which contain less than 10 nCi of long-lived alpha activity per gram.

Source: R. L. Shoup, "International Waste Management Symposium," *Nuclear Safety*, Vol. 18, No. 4, July/August, 1977, p. 502.

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"I'll have to take these for the rest of my life. Thank God."

by Sy Levin.

I'm an advertising copywriter. And I had an assignment to create a message about the cost effectiveness of pharmaceuticals. In other words, that you get back what you pay for them.

I was reviewing the literature when I realized it was talking about me. I have high blood pressure.

My doctor discovered it about six months ago. Today it's very much under control, thanks to a small tablet I take daily.

It's an expense and another daily "must," but when my doctor explained the alternatives, I knew I was ahead of the game.

High blood pressure can lead to kidney failure, stroke, or heart attack. Any of which could, obviously, mean long hospital stays and considerable expense. Or worse!

I consider this cost-effectiveness argument one of the strongest for continuing pharmaceutical research. My own experience is only one example. For some ulcer patients, a drug that can reduce the need for surgery has recently been approved. So has another that dissolves pulmonary blood clots.

Research *will* undoubtedly lead to more breakthrough controls or cures. It'll save more suffering—and a lot of money.

Let's remember that—despite the need to hold down medical care costs. Let's remember that we dare not jeopardize research for better drugs and medical devices.

I'll remember it. Every single day.

The Pharmaceutical Manufacturers Association.

If a new medicine can help, we're working on it.

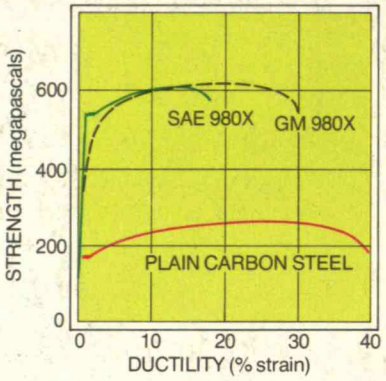
Write for "Drugs and Devices: Tomorrow's Life and Cost Savers." PMA, Dept. CJ-803; 1155 Fifteenth St., N.W.; Wash., D.C. 20005

Putting the heat on high-strength steel to make it shape up.

Why all the interest in using high-strength, low-alloy (HSLA) steel in the automobile? To help cut weight and thus conserve fuel.

Not that HSLA steel is lighter than other steels. It's not. But it can do an equivalent job in a thinner gauge.

Until recently, however, HSLA steel was limited in use to simple shapes because of its poor ductility, or formability. A discovery by our metallurgists here at the General Motors Research Laboratories changed all that. They found that contrary to traditional belief, ductility can be greatly increased without sacrificing strength.

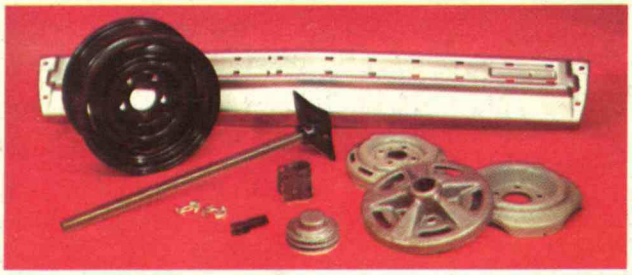


How? By heat treating. The treatment is applied to commercial SAE 980X steel. It improves ductility as much as 50% by dissolving brittle carbide particles in the microstructure and then introducing a strong but ductile second phase (martensite) through controlled cooling.

Result #1 was a new steel called GM 980X. Although weakened by annealing, which enables it to form into complex shapes, it recoups its high strength during forming.

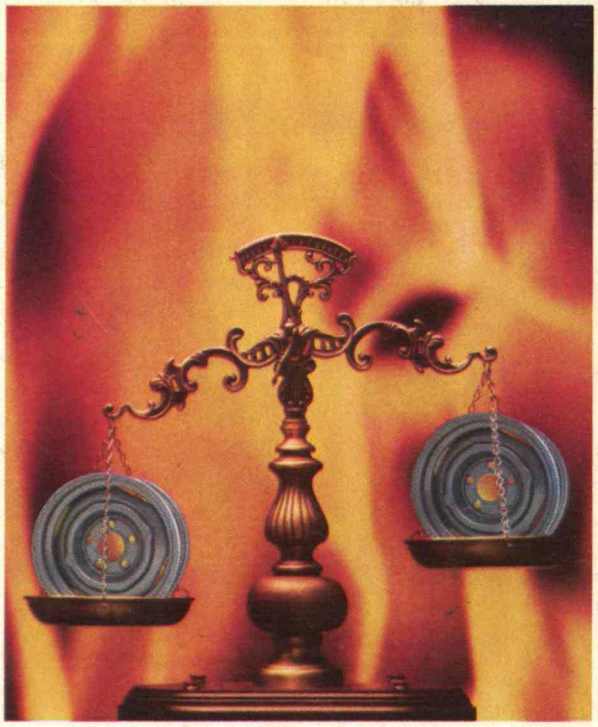
Significantly, steel companies can employ our heat treatment with their existing annealing facilities to make this more ductile HSLA steel. And they are now doing so.

Result #2: GM 980X is already being used to stamp lighter weight parts for production and prototype automobiles.



Result #3: The research behind GM 980X has stirred considerable activity in the steel industry, at universities, and in independent laboratories throughout the world to develop additional HSLA steels having better strength-ductility properties.

All in all, just part of GM's continuing effort to help America meet the growing energy challenge.



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